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Wireless world

MARCH 1984

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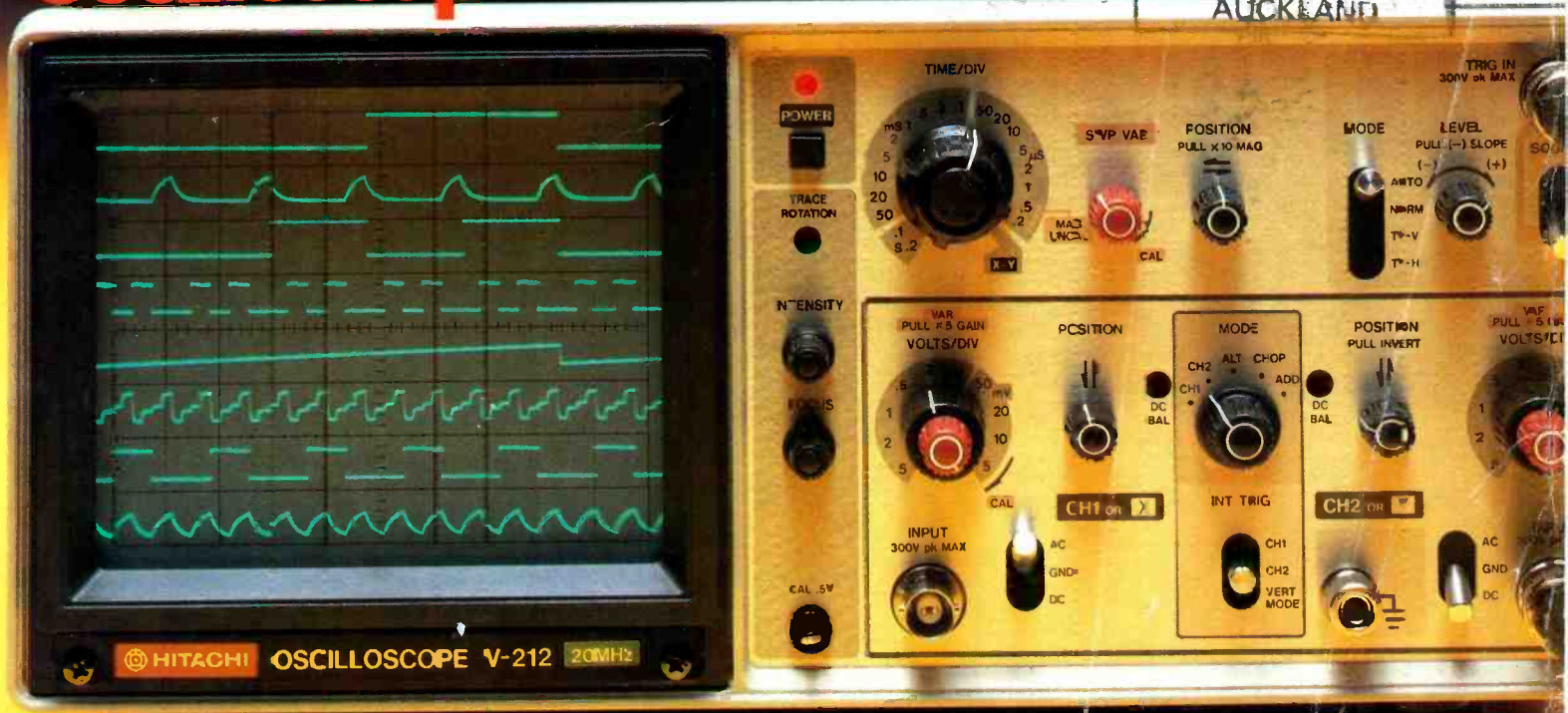
AUCKLAND

Oscilloscopes



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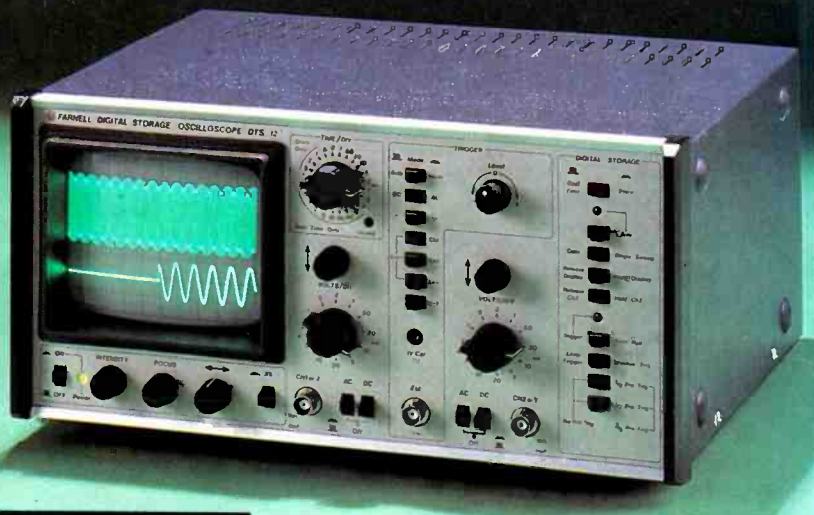

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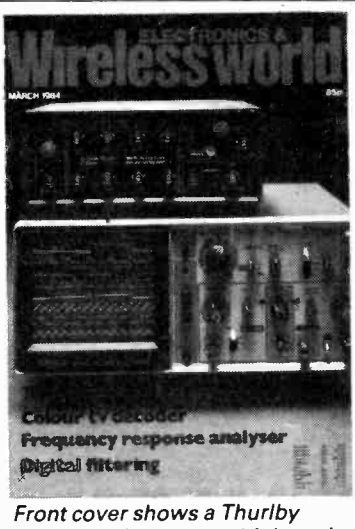

Front cover shows a Thurlby OM358 eight-trace multiplexer in use with a Hitachi V121 dual-trace oscilloscope to introduce our oscilloscope survey on page 57. Picture supplied by Thurlby.

NEXT MONTH

Bob Coates turns the Picotutor's 68705 microprocessor into a simple, low-cost interface for driving a teletypewriter from a microcomputer Centronics port.

As well as providing 5.5 and 6MHz sound, a synthesized tv modulator can be accurately switched to any u.h.f. channel.

Testing microprocessor systems is not so simple for the first-time builder without access to logic analysers or emulators. Carson gives some simple procedures that highlight hardware and software problems.

Surface wave, charge transfer and digital v.l.s.i. devices have enabled complex and powerful matched filters to be made. Geoffrey Robinson describes some examples that illustrate their different forms and uses.

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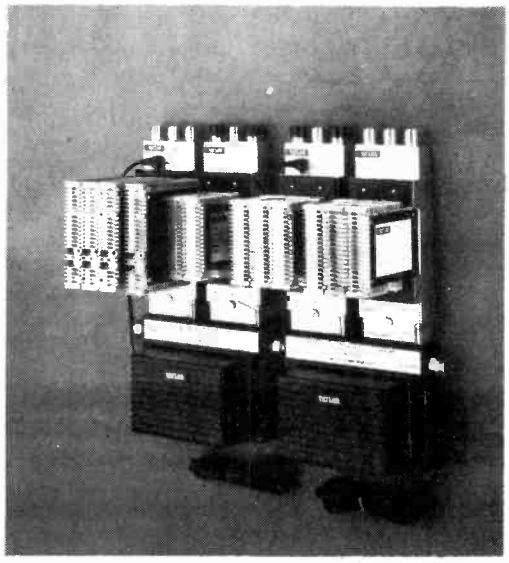
CABLE T.V. HEAD END AND REPEATER AMPLIFIERS



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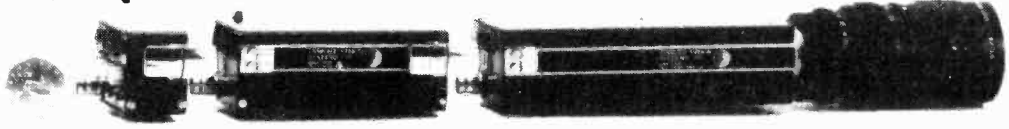

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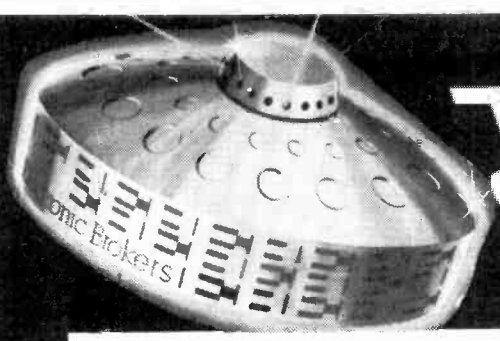

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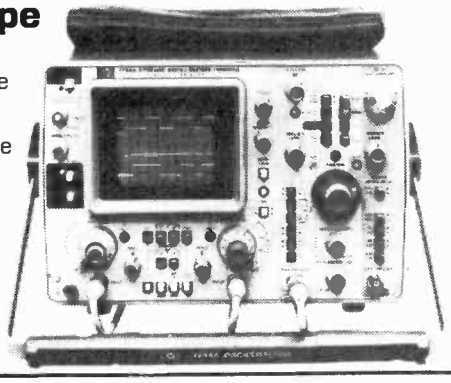

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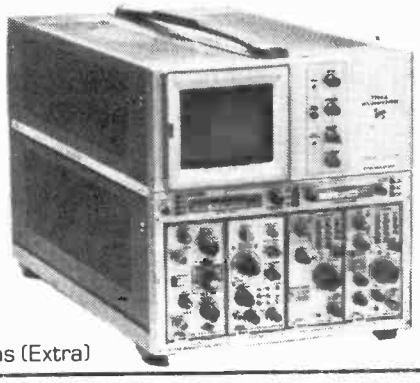

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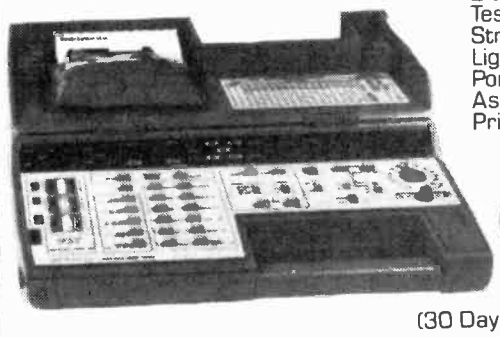

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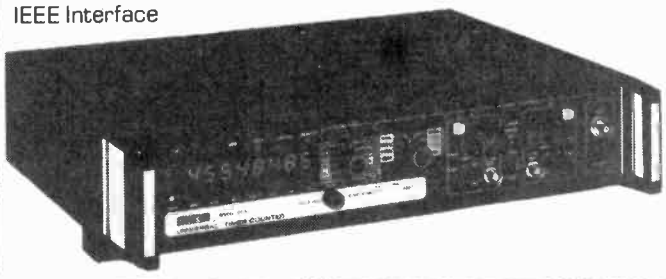

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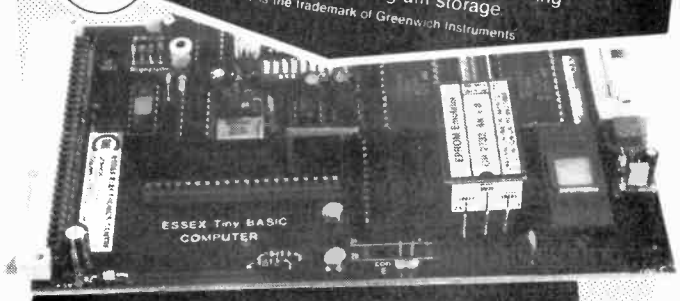

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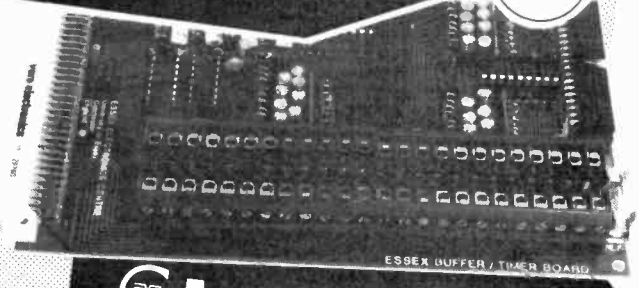

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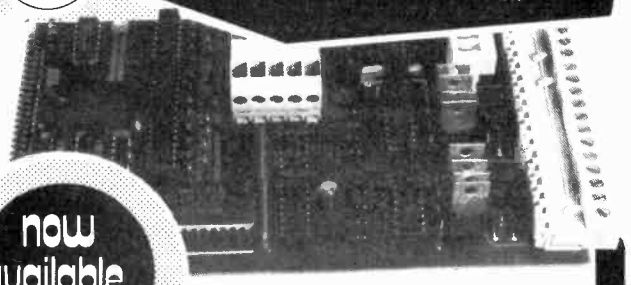

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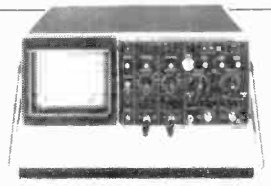

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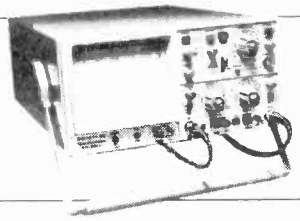
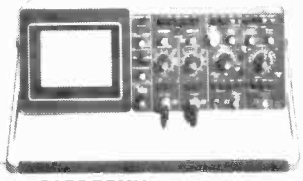
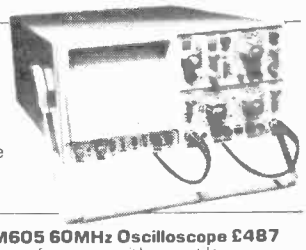


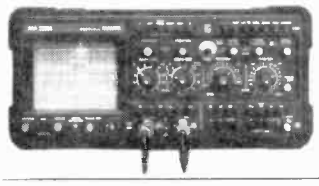
Hameg HM203-4 20MHz Oscilloscope £264
Designed for general purpose applications in industry and education. Versatile triggering performance to at least 40MHz. Dual trace X-Y operation, TV triggering, add and invert mode and component tester make the price/performance ratio of this scope most attractive.

Philips PM3219 Storage Oscilloscope £2675
Provides comprehensive, cost effective storage of single-shot transients and low frequency events. Variable persistence and variable storage. Auto erase between 1 and 10 seconds, and read button facility. Auto store up to 1 minute, up to 24 hours in 'baby sit' mode. 2mV sensitivity at 50MHz

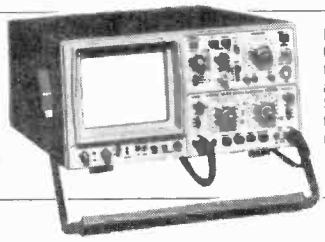


Hameg HM204 20MHz Oscilloscope £365
High performance scope with peak value triggering up to 50MHz. Versatile triggering facilities and variable hold off control. Dual trace, delayed sweep mode. Z modulation, X-Y operation, internal illuminated graticule and component tester complete the attractive specification.



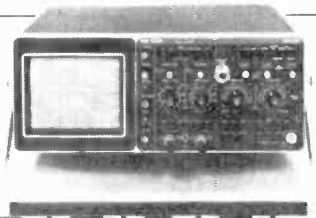


Philips PM3256 75MHz Oscilloscope £1245
Tough, light-weight ruggedised unit, with shoulder strap, that can be used in harsh service environments. Fast trigger circuits to over 100MHz. TTL triggering is standard. Trigger view third channel and full X-Y display. Dual trace with 2mV sensitivity and delayed time base.
Philips PM 3254 Single time base £1145



Hameg HM605 60MHz Oscilloscope £487
Outstanding performance with versatile triggering to 80MHz. Sensitivity 1mV to 30MHz and 2mV above. Bright display from 14kV CRT. Switchable 1kHz/1MHz probe calibrator. Dual trace, delayed sweep, X-Y operation, Z modulation, internal illuminated graticule and component tester.

Philips PM3267 100MHz Oscilloscope £1250
Versatile and economic instrument designed for advanced electronic environments. Separate main and delayed time base controls with comprehensive triggering facilities and trigger view third channel. Dual trace, 2mV sensitivity, full X-Y display, Z modulation and internal illuminated graticule.



Hameg HM705 70MHz Oscilloscope £588
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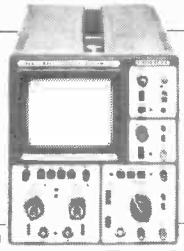

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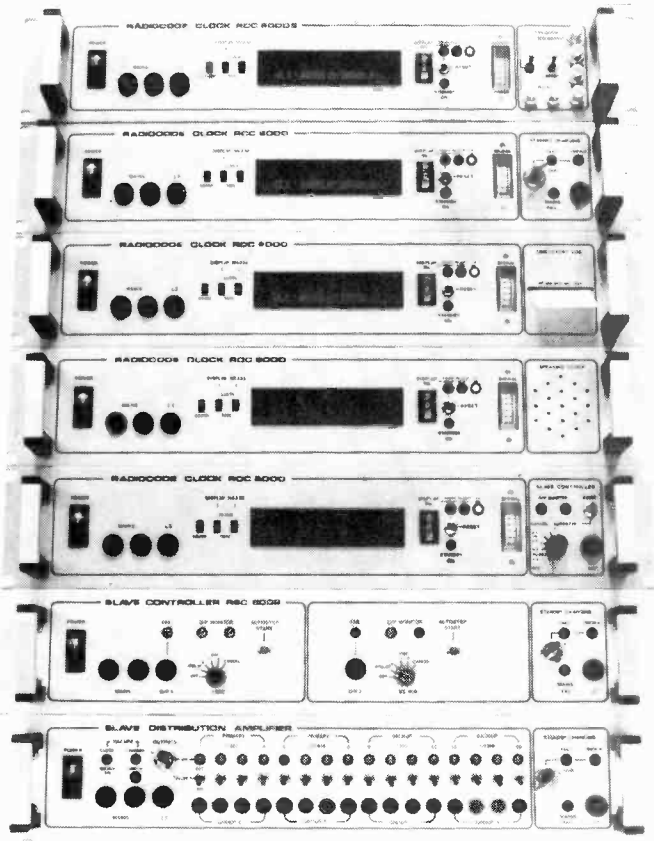

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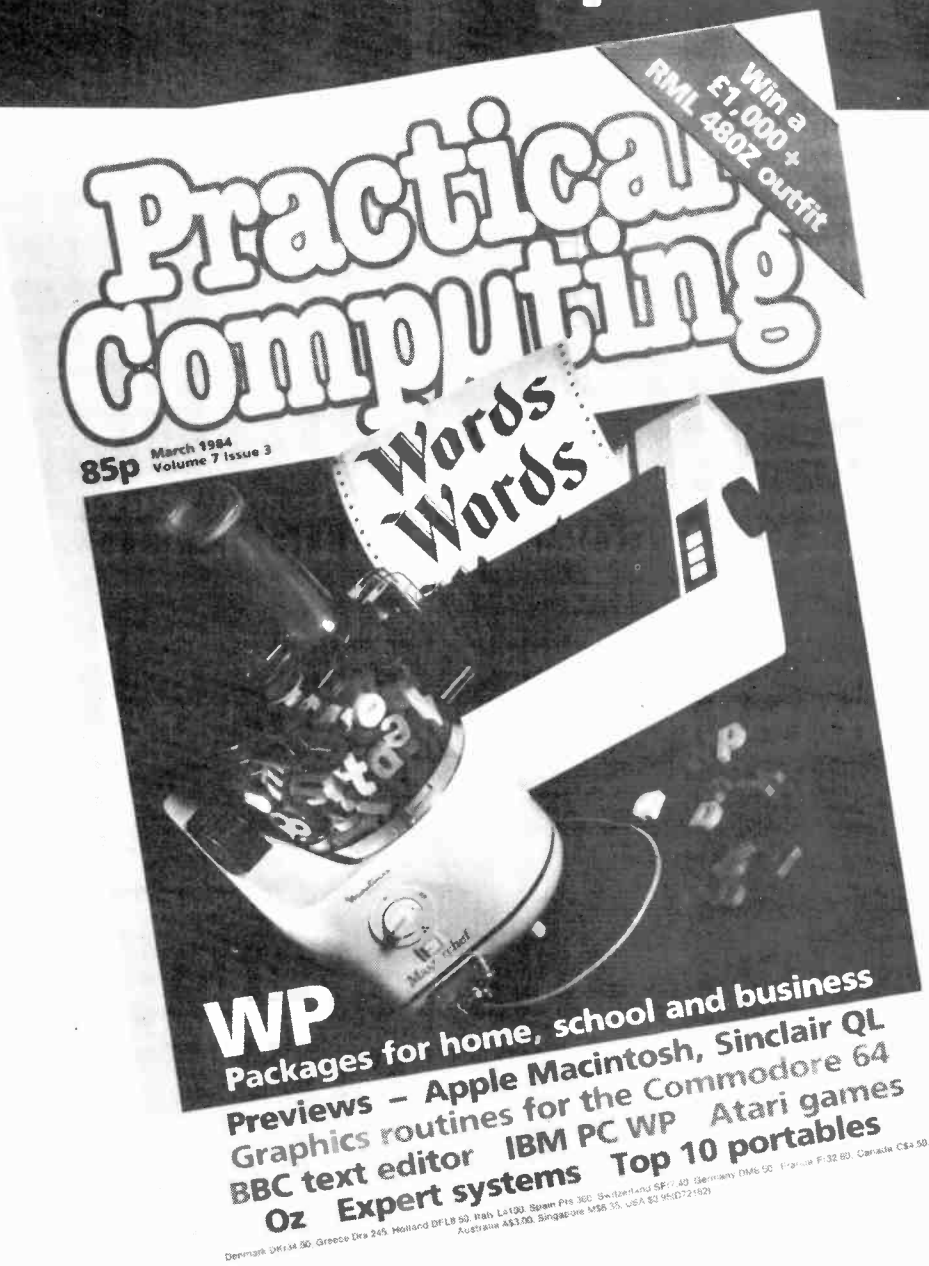
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SN75174		1.64
SN75175		1.21
SN75182		0.62
SN75183		0.62
SN75188		0.44
SN75189		0.44
SN75451BP		0.24
SN75452BP		0.24
SN75453BP		0.24
SN75454BP		0.24
SN75468N		1.08
SN75491AN		0.46
SN75492AN		0.61
TL010CP		0.38
TL061CLP		0.28
TL062CP		0.47
TL064CN		0.89
TL066CP		0.28
TL071CP		0.28
TL072CP		0.47
TL074CN		0.91
TL081CP		0.24
TL082CP		0.41
TL084CN		0.85
TL091CP		0.41
TL092CP		0.60
TL094CN		1.37
TL487CP		0.55
TL489CP		0.55
TL494CN		1.66
TL496CP		0.30
TL507CP		1.02
ZN450E		5.25
ZN451E		6.38
ZN451KIT		25.65

DIL Sockets

Pin	Tin	Gold	W/W
8	0.10	0.24	0.58
14	0.12	0.28	0.77
16	0.13	0.32	0.86
18	0.16	0.32	1.08
20	0.17	0.41	1.23
22	0.17	0.48	1.31
24	0.20	0.63	1.44
28	0.23	0.57	1.59
40	0.33	0.99	1.96

ZIF Sockets

24 Pin	5.80
28 Pin	6.35
40 Pin	8.45

Data sheets are available on items marked D.
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D2	1.00	D6	3.00
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D4	2.00		

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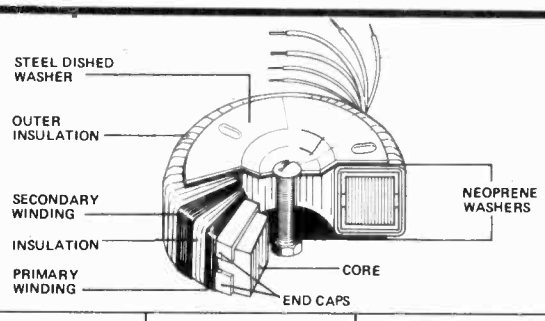

15 VA
62 x 34mm 0.35Kg
Regulation 19%

SERIES No	SECONDARY Volts	RMS Current
0x010	6+6	1.25
0x011	9+9	0.83
0x012	12+12	0.63
0x013	15+15	0.50
0x014	18+18	0.42
0x015	22+22	0.34
0x016	25+25	0.30
0x017	30+30	0.25

(encased in ABS plastic)

30 VA
70 x 30mm 0.45Kg
Regulation 18%

1x010	6+6	2.50
1x011	9+9	1.66
1x012	12+12	1.25
1x013	15+15	1.00
1x014	18+18	0.83
1x015	22+22	0.68
1x016	25+25	0.60
1x017	30+30	0.50

50 VA
80 x 35mm 0.9Kg
Regulation 13%

2x010	6+6	4.16
2x011	9+9	2.77
2x012	12+12	2.08
2x013	15+15	1.66
2x014	18+18	1.38
2x015	22+22	1.13
2x016	25+25	1.00
2x017	30+30	0.83
2x028	110	0.45
2x029	220	0.22
2x030	240	0.20

80 VA
90 x 30mm 1Kg
Regulation 12%

3x010	6+6	6.64
3x011	9+9	4.44
3x012	12+12	3.33
3x013	15+15	2.66
3x014	18+18	2.22
3x015	22+22	1.81
3x016	25+25	1.60
3x017	30+30	1.33
3x028	110	0.72
3x029	220	0.36
3x030	240	0.33

120 VA
90 x 40mm 1.2Kg
Regulation 11%

4x010	6+6	10.00
4x011	9+9	6.66
4x012	12+12	5.00
4x013	15+15	4.00
4x014	18+18	3.33
4x015	22+22	2.72
4x016	25+25	2.40
4x017	30+30	2.00
4x018	35+35	1.71
4x028	110	1.09
4x029	220	0.54
4x030	240	0.50

160 VA
110 x 40mm 1.8Kg
Regulation 8%

5x011	9+9	8.89
5x012	12+12	6.66
5x013	15+15	5.33
5x014	18+18	4.44
5x015	22+22	3.63
5x016	25+25	3.20
5x017	30+30	2.66
5x018	35+35	2.28
5x026	40+40	2.00
5x028	110	1.45
5x029	220	0.72
5x030	240	0.66

225 VA
110 x 45mm 2.2Kg
Regulation 7%

6x012	12+12	9.38
6x013	15+15	7.50
6x014	18+18	6.25
6x015	22+22	5.11
6x016	25+25	4.50
6x017	30+30	3.75
6x018	35+35	3.21
6x026	40+40	2.81
6x025	45+45	2.50
6x033	50+50	2.25
6x028	110	2.04
6x029	220	1.02
6x030	240	0.93

300 VA
110 x 50mm 2.6Kg
Regulation 6%

7x013	15+15	10.00
7x014	18+18	8.33
7x015	22+22	6.82
7x016	25+25	6.00
7x017	30+30	5.00
7x018	35+35	4.28
7x026	40+40	3.75
7x025	45+45	3.33
7x033	50+50	3.00
7x028	110	2.72
7x029	220	1.36
7x030	240	1.25

500 VA
140 x 60mm 4Kg
Regulation 4%

8x016	25+25	10.00
8x017	30+30	8.33
8x018	35+35	7.14
8x026	40+40	6.25
8x025	45+45	5.55
8x033	50+50	5.00
8x042	55+55	4.54
8x028	110	4.54
8x029	220	2.27
8x030	240	2.08

625 VA
140 x 75mm 5Kg
Regulation 4%

9x017	30+30	10.41
9x018	35+35	8.92
9x026	40+40	7.81
9x025	45+45	6.94
9x033	50+50	6.25
9x042	55+55	5.68
9x028	110	5.68
9x029	220	2.84
9x030	240	2.60

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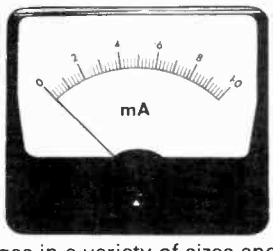

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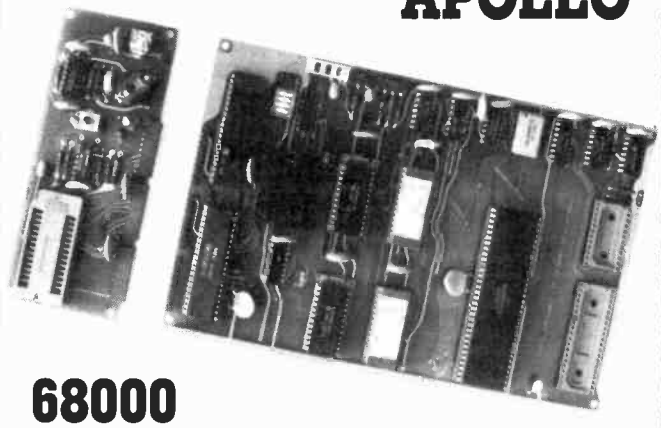

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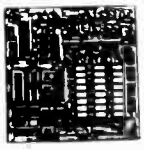

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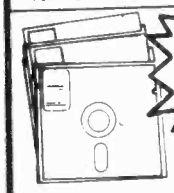

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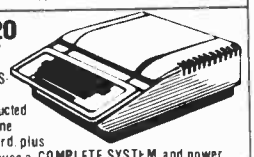

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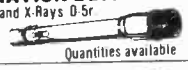

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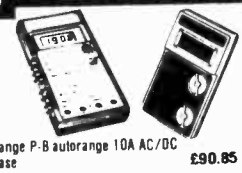

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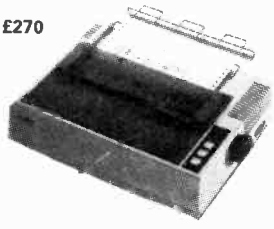

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UV1T Eraser with a built-in timer and mains indicator. Built-in safety interlock to avoid accidental exposure to the harmful UV rays. It can handle up to 5 eproms at a time with an average erasing time of about 20 mins. **£59** + **£2** p&p.
UV1 as above but without the timer **£47** + **£2** p&p.
UV140 up to 14 Eproms **£61**.
UV141 as above but with timer **£79**.

★★ ATTENTION ★★

All prices in this double page spread are subject to change without notice.

ACORN IEEE INTERFACE

This IEEE 488 standard interface is a general purpose system for exchanging digital data between a number of devices in a local area. The interface complies with the IEC 625-1 standard and can be connected to up to 14 other devices. Interface board is supplied complete with software in ROM, interconnecting cables, IEEE cable for connection to an external device and a comprehensive manual. **£282.50** + **£2.50** carr.

SMARTMOUTH

The 'infinite vocabulary' self-contained speech synthesiser unit. Uses only 5-10 bytes per word – no ROMs required – simply plugs into the user port. (Has Aux. Audio output skt.). Supplied with Demo/Development programs and simple software instructions, **£37** + **£2** p. & p.

NEW COMPREHENSIVE CATALOGUE AVAILABLE – PLEASE SEND FOR PRICE LIST

CONNECTOR SYSTEMS

I.D. CONNECTORS

(Speedblock Type)

No of ways	Header Plug	Recep-tacle	Edge Conn.
10	90p	85p	120p
20	145p	125p	195p
26	175p	150p	240p
34	200p	160p	320p
40	220p	190p	340p
50	235p	200p	390p

D CONNECTORS

	No. of ways 9	15	25	37
MALE				
Solder	80p	105p	160p	250p
Angled	150p	210p	250p	365p
FEMALE				
Solder	105p	160p	200p	335p
Angled	165p	215p	290p	440p
Hoods	90p	85p	90p	100p

IDC 15-way plug **340p**. Socket **400p**
IDC 25-way plug **385p**. Socket **450p**

TEXTOOL ZIF

SOCKETS 24-pin **£5.75** 28-pin **£8.00** 40-pin **£9.75**

DIL SWITCHES

4-way 70p 8-way 90p
6-way 85p 10-way 140p

JUMPER LEADS

24" Ribbon Cable with Headers

	14-pin	16-pin	24-pin	40-pin
1 end	145p	165p	240p	350p
2 ends	210p	230p	345p	540p

24" Ribbon Cable with Sockets

	20-pin	26-pin	34-pin	40-pin
1 end	160p	200p	280p	300p
2 ends	290p	370p	480p	525p

Ribbon Cable with D. Conn.
25-way Male 500p Female 550p

RS 232 JUMPERS

(25-way D)

24" Single end Male	£5.00
24" Single end Female	£5.25
24" Female-Female	£10.00
24" Male-Male	£9.50
24" Male-Female	£9.50

DIL HEADERS

	Solder Type	IDC Type
14pin	40p	100p
16pin	50p	110p
24pin	100p	150p
40pin	200p	225p

AMPHENOL CONNECTORS

36-way plug Centronics Parallel Solder **£5.25** IDC **£4.95**
36-way socket Centronics Parallel Solder **£5.50** IDC **£5.20**
24-way plug IEEE Solder **£5** IDC **£4.75**
24-way socket IEEE Solder **£5**

EURO CONNECTORS

	Plug	Skt.
DIN 41617		
21-way	160p	165p
31-way	170p	170p
DIN 41612		
2×32-way St. Pin	220p	275p
2×32-way Ang. Pin	275p	320p
3×32-way St. Pin	260p	300p
3×32-way Ang. Pin	375p	350p

TEST CLIPS

14-pin 275p 16-pin £3
40-pin £6

RIBBON CABLE

(Grey/meter)

10-way	40p
16-way	60p
20-way	85p
26-way	120p
34-way	160p
40-way	180p
50-way	200p
64-way	280p

EDGE CONNECTORS

	0.1"	0.156"
2×12-way (Vic)	350p	–
2×18-way	–	140p
2×22-way	190p	240p
2×23-way	175p	–
2×25-way	225p	220p
2×28-way	190p	–
1×43-way	260p	–
2×43-way	365p	
1×77-way	600p	
S100 Conn		600p

www.americanradiohistory.com

74 SERIES

7400	25p
7401	25p
7402	25p
7403	25p
7404	25p
7405	30p
7406	POA
7407	POA
7408	25p
7409	25p
7410	25p
7411	25p
7412	25p
7413	40p
7414	60p
7416	POA
7417	POA
7420	25p
7421	25p
7422	30p
7423	30p
7425	35p
7426	30p
7427	30p
7428	30p
7430	25p
7432	30p
7433	25p
7437	25p
7438	100p
7439	38p
7440	25p
7441	70p
7442A	60p
7444	70p
7445	90p
7446A	90p
7447A	75p
7448	90p
7450	25p
7451	25p
7453	25p
7454	25p
7460	30p
7470	30p
7472	36p
7473	30p
7474	40p
7475	40p
7476	35p
7480	48p
7481	120p
7482	120p
7483A	75p
7484A	90p
7485	90p
7486	36p
7489	170p
7490A	45p
7491	60p
7492A	50p
7493A	45p
7494	90p
7495A	48p
7496	60p
7497	120p
74100	120p
74104	50p
74105	55p
74107	45p
74109	45p
74110	60p
74111	55p
74112	170p
74116	120p
74118	120p
74119	100p
74120	100p
74121	40p
74122	45p
74123	90p
74125	50p
74126	50p
74128	70p
74132	43p
74136	45p
74141	70p
74142	175p
74143	200p
74144	200p
74145	90p
74147	120p
74148	120p
74150	150p
74151A	60p
74153	60p
74154	120p
74155	55p
74156	55p
74157	55p
74159	150p
74160	55p
74161	55p
74162	55p
74163	55p
74164	60p
74165	75p
74166	90p
74167	200p
74170	150p
74172	250p
74173	65p
74174	60p
74175	60p
74176	55p
74177	50p
74178	90p
74179	90p
74180	55p
74181	140p
74182	50p
74184	120p
74185A	120p
74190	60p
74191	60p
74192	60p
74193	60p
74194	50p
74195	50p
74196	48p
74197	48p
74198	120p
74199	120p
74221	100p
74251	60p
74259	150p
74265	55p
74273	150p
74276	120p
74278	100p
74279	55p
74283	50p
74285	160p
74286	180p
74290	150p
74293	90p
74298	120p
74351	150p
74365A	48p
74366A	48p
74367A	48p
74368A	48p
74376	100p
74390	90p
74393	150p
74490	120p

74LS SERIES

74LS00	25p
74LS01	20p
74LS02	20p
74LS03	20p
74LS04	30p
74LS05	20p
74LS08	20p
74LS09	20p
74LS10	30p
74LS11	20p
74LS12	20p
74LS13	28p
74LS14	50p
74LS15	20p
74LS20	20p
74LS21	20p
74LS22	20p
74LS26	20p
74LS27	20p
74LS28	20p
74LS30	20p
74LS32	60p
74LS33	20p
74LS37	20p
74LS38	60p
74LS40	20p
74LS42	45p
74LS47	60p
74LS48	60p
74LS51	20p
74LS54	20p
74LS55	20p
74LS73A	30p
74LS74A	40p
74LS75	36p
74LS76A	27p
74LS83A	48p
74LS85	60p
74LS86	30p
74LS90	32p
74LS91	60p
74LS92	40p
74LS93	32p
74LS95B	50p
74LS96	90p
74LS107	33p
74LS109	33p
74LS112	33p
74LS113	30p
74LS114	32p
74LS122	60p
74LS123	120p
74LS124/629	150p
74LS125	45p
74LS126	45p
74LS132	42p
74LS133	30p
74LS136	30p
74LS138	50p
74LS139	50p
74LS145	90p
74LS147	120p
74LS148	120p
74LS151	50p
74LS153	50p
74LS154	150p
74LS155	40p
74LS156	40p
74LS157	40p
74LS158	35p
74LS160A	60p
74LS161A	60p
74LS162A	75p
74LS163A	90p
74LS164	60p
74LS165A	75p
74LS166A	120p
74LS168	140p
74LS169	110p
74LS170	100p
74LS173A	120p
74LS174	60p
74LS175	54p
74LS181	120p
74LS183	120p
74LS190	60p
74LS191	60p
74LS192	60p
74LS193	60p
74LS194A	50p
74LS196	60p
74LS197	54p
74LS221	90p
74LS240	120p
74LS241	120p
74LS242	75p
74LS243	75p
74LS244	140p
74LS245	175p
74LS247	70p
74LS248	70p
74LS249	70p
74LS251	45p
74LS253	45p
74LS256	200p
74LS257A	45p
74LS258A	45p
74LS259	120p
74LS260	35p
74LS261	80p
74LS266	25p
74LS273	140p
74LS275	175p
74LS279	45p
74LS280	180p
74LS283	50p
74LS290	55p
74LS292	900p
74LS293	50p
74LS295	70p
74LS297	900p
74LS298	90p
74LS299	200p
74LS321	240p
74LS323	200p
74LS324/624	150p
74LS348	140p
74LS352	70p
74LS353	70p
74LS356	175p
74LS363	180p
74LS364	180p
74LS365A	36p
74LS366A	36p
74LS367A	36p
74LS368A	36p
74LS373	120p
74LS374	120p
74LS375	60p
74LS377	120p
74LS378	85p
74LS379	120p
74LS390	75p
74LS393	120p
74LS395A	100p
74LS399	120p
74LS445	100p
74LS465	120p
74LS466	120p
74LS467	120p
74LS490	130p
74LS540	120p
74LS541	150p
74LS608	700p
74LS610	£19
74LS612	£19
74LS624	150p
74LS626	150p
74LS628	150p
74LS629	150p
74LS640	200p
74LS640-1	250p
74LS641	200p
74LS642-1	250p
74LS643	200p
74LS643-1	250p
74LS644	200p
74LS645	200p
74LS645-1	250p
74LS668	70p
74LS669	70p
74LS670	120p
74LS674	550p
74LS682	250p
74LS684	400p
74LS687	450p

74S SERIES

74S00	45p
74S02	45p
74S04	60p
74S05	60p
74S08	60p
74S10	40p
74S11	50p
74S20	40p
74S22	50p
74S30	40p
74S32	70p
74S37	60p
74S51	75p
74S74	75p
74S85	300p
74S86	90p
74S112	90p
74S113	90p
74S114	90p
74S124	300p
74S132	110p
74S133	60p
74S138	110p
74S139	120p
74S140	60p
74S151	180p
74S153	180p
74S157	250p
74S158	195p
74S163	300p
74S174	250p
74S175	320p
74S188	150p
74S194	300p
74S195	300p
74S196	300p
74S225	650p
74S240	250p
74S241	300p
74S244	300p
74S251	250p
74S257	250p
74S258	250p
74S260	70p
74S261	300p
74S283	300p
74S299	550p
74S373	400p
74S374	400p

4000 CMOS

4000	18p
4001	16p
4002	16p
4006	50p
4007	16p
4008	45p
4009	24p
4010	24p
4011	16p
4012	16p
4013	36p
4014	48p
4015	40p
4016	22p
4017	40p
4018	45p
4019	40p
4020	70p
4021	40p
4022	45p
4023	18p
4024	36p
4025	16p
4026	80p
4027	20p
4028	38p
4029	45p
4030	20p
4031	125p
4032	70p
4033	125p
4034	140p
4035	55p
4036	200p
4037	110p
4038	75p
4039	225p
4040	40p
4041	40p
4042	40p
4043	40p
4044	40p
4045	105p
4046	50p
4047	50p
4048	50p
4049	24p
4050	24p
4051	48p
4052	48p
4053	50p
4054	75p
4055	75p
4056	75p
4059	450p
4060	55p
4063	75p
4066	38p
4067	225p
4068	16p
4069	20p
4070	16p
4071	16p
4072	16p
4073	16p
4075	16p
4076	48p
4077	27p
4078	16p
4081	16p
4082	16p
4085	40p
4086	40p
4089	125p
4093	30p
4094	65p
4095	75p
4096	70p
4097	290p
4098	90p
4099	60p
4500	575p
4501	28p
4502	60p
4503	45p
4504	75p
4505	400p
4506	120p
4507	35p
4508	130p
4510	48p
4511	45p
4512	48p
4513	195p
4514	100p
4515	100p
4516	50p
4517	260p
4518	48p
4519	30p
4520	50p
4521	90p
4522	60p
4526	60p
4527	60p
4528	50p
4531	55p
4532	70p
4534	400p
4536	270p
4538	70p
4539	60p
4541	90p
4543	75p
4553	245p
4555	45p
4556	45p
4557	300p
4560	120p
4566	160p
4568	250p
4569	170p
4572	35p
4583	75p
4584	36p
4585	50p
4599	290p
4724	150p
14411	750p
14412	850p
14416	300p
14419	270p
14490	350p
14495	450p
14500	575p
22100	290p
22101	350p
22102	700p
40014	700p
40085	36p
40097	90p

COUNTERS

74C925	£4
74C926	£5
74C928	£6
72168	£22
ZN1040	670p

DIL SWITCHES

4-way	90p
8-way	120p
6-way	105p
10-way	150p

LINEAR ICs

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ADC0808	990p
AN103	200p
AY1-5050	99p
AY3-1270	750p
AY3-1350	350p
AY3-8910	400p
AY3-8912	500p
AY5-3600	800p
CA3019A	80p
CA3028A	120p
CA3046	70p
CA3048	220p
CA3059	350p
CA3060	350p
CA3080E	70p
CA3086	60p
CA3089E	200p
CA3090AQ	375p
CA3130E	90p
CA3130T	110p
CA3140E	45p
CA3140T	90p
CA3160E	100p
CA3161E	150p
CA3162E	450p
CA3189E	300p
CA3240E	110p
CA3280G	200p
D7002	390p
DAC0800	£2
DAC0808	£2
DG308	300p
HA1366	190p
HA1837	250p
ICL7106	700p
ICL7611	95p
ICL7650	400p
ICL7660	250p
ICL8038	300p
ICM7217	750p
ICM7555	100p
ICM7556	140p
LC7120	300p
LC7130	325p
LC7137	350p
LF347	150p
LF351	48p
LF353	95p
LF355	95p
LF356P	95p
LF357	110p
LF13331	350p
LM10C	325p
LM301A	25p
LM307	45p
LM308CN	75p
LM310	120p
LM311	70p
LM318	150p
LM319	160p
LM319N	160p
LM324	30p
LM334Z	90p
LM335Z	140p
LM339	40p
LM348	65p
LM358P	60p
LM377	225p
LM380	75p
LM381AN	180p
LM382	120p
LM386	90p
LM387	120p
LM389	95p
LM391	150p
LM392N	80p
LM393	100p
LM394CH	300p
LM709	36p
LM710	50p
LM711	70p
LM725C	300p
LM733	60p
LM741	18p
LM747	70p
LM748	35p
LM1011	480p
LM1014	150p
LM1801	300p
LM1830	250p
LM1871	300p
LM1872	300p
LM1886	500p
LM1889	350p
LM2917	200p
LM3302	75p
LM3900	50p
LM3909	85p
LM3911	125p
LM3914	250p
LM3915	250p
LM3916	250p
LM13600	110p
M51513L	230p
M51516L	500p
MB3712	200p
MB3730	400p
MC1310P	150p
MC1413	75p
MC1458	38p
MC1493	100p
MC1495L	350p
MC1496	70p
MC3340P	160p
MC3401	50p
MC3403	65p
MF10CN	360p
MK50240	900p
MK50398	790p
ML920	800p
MM57160	620p
MN6221A	600p
NE531	140p
NE544	190p
NE555	18p
NE556	45p
NE564	420p
NE565	120p
NE566	155p
NE567	140p
NE570	410p
NE571	400p
NE592	80p
NE5532P	200p
NE5533	160p
NE5534P	110p
NE5534AP	140p
PLL02A	500p
RC4136	60p
S566B	225p
SAA1900	£16
SAD1024A	1150p
SFF96364	800p
SN76488	500p
SN76489	400p
SN76495	400p
SP0256AL2	£10
TA7120	150p
TA7130	160p
TA7204	150p
TA7205	90p
TA7222	150p
TA7310	150p
TBA231	120p
TBA800	80p
TBA810	100p
TBA820	80p
TBA950	225p
TC9109	750p
TCA210	350p
TCA220	350p
TCA270	350p
TCA940	175p
TCA965	120p
TDA1004A	£4
TDA1008	320p
TDA1010	250p
TDA1022	500p
TDA1024	120p
TDA1170	300p
TDA2002	325p
TDA2003	325p
TDA2004	400p
TDA2006	350p
TDA2020	320p
TDA7000	350p
TL061CP	40p
TL062	85p
TL064	100p
TL071	30p
TL072	50p
TL074	100p
TL081	25p
TL082	45p
TL083	75p
TL084	90p
TL094	200p
TL170	50p
TL430C	70p
UA1003-3	935p
UA2240	120p
UAA170	170p
ULN2003A	75p
ULN2004	75p
ULN2068	290p
ULN2802	200p
ULN2803	200p
ULN2804	200p
UPC575	275p
UPC592H	200p
UPC1156H	£3
UPC1185H	£5
XR210	400p
XR2206	400p
XR2211	575p
XR2240	120p
ZN414	100p
ZN419C	190p
ZN423E	130p
ZN424E	130p
ZN425E	350p
ZN426E	300p
ZN427E	600p
ZN428E	450p
ZN429E	210p
ZN450E	750p
ZN459CP	250p
ZN1034E	200p
ZN1040E	670p
ZNA134J	£23
ZNA234E	950p

VOLTAGE REGULATORS

FIXED PLASTIC

	+ve		-ve	
1A	7805	40p	7905	45p
5V	7806	40p	7906	45p
6V	7808	50p	7908	50p
8V	7812	40p	7912	45p
12V	7815	40p	7915	45p
15V	7818	50p	7918	50p
18V	7824	40p	7924	45p
24V				
5V 100mA	78L05	30p	79L05	45p
6V 100mA	78L06	30p		
8V 100mA	78L08	30p		
12V 100mA	78L12	30p	79L12	50p
15V 100mA	78L15	30p	79L15	50p

OTHER REGULATORS

LM309K 1A 5V	140p	78P05	900p
LM317K T03	250p	78H12	850p
LM317T	100p	78HGKC	600p
LM337T	225p	78HO5KC	650p
LM323K 3A 5V	450p	78GUIC	200p
LM350T	350p	79GUIC	225p
LM723N	30p	79HGKC	700p
TL494	300p	ICL 7660	250p
TL497	300p	LM305AH	250p
78S40	225p	SG3524	300p

OPTO ELECTRONICS

2N5777	48p	TIL32	55p
OCP71	180p	TIL78	55p
ORP12	120p	TIL31A	120p
ORP60	120p	TIL81	120p
ORP61	120p	TIL100	75p

OPTO ISOLATORS

ILD74	130p	TIL111	70p
MCT26	100p	TIL112	70p
MCS2400	190p	TIL113	70p
MOC3020	150p	TIL116	70p
ILQ74	180p		

LEDs

0.125"		FND357	120p
TIL209 Red	10p	FND500	140p
TIL211 Gr	12p	FND507	140p
TIL212 Yel	15p	MAN4640	200p
		MAN8910	250p
0.2"		NSB5881	570p
TIL220 Red	10p	TIL311	600p
TIL222 Gr	12p	TIL321/3	130p
TIL228 Yel	15p	TIL330	140p
Rectangular		7750/60	200p
LEDs (R,G,Y)	30p	Bargraph	225p

DISPLAYS

DL704	140p
DL707 Red	140p

DRIVERS

9368	250p
9370	300p

COMPUTER COMPONENTS

CPUs

1802CE	650p
2650A	£12
6502	350p
6502A	500p
6800	225p
6802	250p
6809	650p
68B09	£12
6809E	£9
68B09E	£16
6800L8	£48
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8155	350p
8156	350p
8205	225p
8212	110p
8216	100p
8224	110p
8226	250p
8228	270p
8243	280p
8250	1150p
8251	300p
8253	390p
8255	300p
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DS8830	150p
DS8831	140p
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DS8836	150p
DS8838	225p
DS8880	170p
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MC1488	100p
MC1489	100p
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MC3459	450p
MC3470	650p
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MC3486	500p
MC3487	300p
MC4024	325p
MC4044	325p
MC14412	750p
75107	90p
75110/12	160p
75114/15	160p
75121/22	140p
75150P	120p
75154	140p
75159	220p
75365	150p
75451/2	72p
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16 pin	11p	22 pin	22p	40 pin 30p

WIRE WRAP SOCKETS BY TI

8 pin	30p	18 pin	50p	24 pin 75p
14 pin	42p	20 pin	66p	28 pin 100p
16 pin	45p	22 pin	75p	40 pin 130p

BFR96	180p
BFX29	40p
BFX30	27p
BFX84/5	40p
BFX86/7	27p
BFX88	27p
BFX89	180p
BFY50	30p
BFY51/2	30p
BFY56	33p
BFY90	80p
BRY39	45p
BSX19/20	24p
BU104	225p
BU105	190p
BU108	250p
BU109	225p
BU126	150p
BU180A	120p
BU205	200p
BU208	200p
BU406	145p
BUX80	600p
BUY69C	350p
E310	50p
MJ413	250p
MJ802	400p
MJ2501	225p
MJ2955	90p
MJ3001	225p
MJ4502	400p
MJE340	80p
MJE2955	100p
MJE3055	70p
MPF102	40p
MPF103/4	30p
MPF105	30p
MPSA06	30p
MPSA12	50p
MPSA13	50p
MPSA20	50p
MPSA42	50p
MPSA43	50p
MPSA56	32p
MPSA70	50p
MPSA93	40p
MPSU06	63p
MPSU07	60p
MPSU45	90p
MPSU65	78p
TIP29A	35p
TIP29C	40p
TIP30A	35p
TIP30C	40p
TIP31A	40p
TIP31C	45p
TIP32A	45p
TIP32C	40p
TIP33A	70p
TIP33C	80p
TIP34A	90p
TIP34C	120p
TIP35A	120p
TIP35C	140p
TIP36A	140p
TIP36C	150p
TIP41A	50p
TIP41C	55p
TIP42A	60p
TIP42C	65p
TIP54	160p
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TIP121	75p
TIP122	80p
TIP125	75p
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2N697	25p
2N698	45p
2N706A	30p
2N708	30p
2N918	45p
2N930	18p
2N1131/2	36p
2N1613	25p
2N1711	25p
2N2102	70p
2N2160	350p
2N2219A	25p
2N2222A	25p
2N2369A	17p
2N2484	25p
2N2646	40p
2N2904/5	25p
2N2906A	25p
2N2907A	25p
2N2926	9p
2N3053	30p
2N3054	55p
2N3055	50p
2N3442	140p
2N3553	240p
2N3584	250p
2N3643/4	48p
2N3702/3	10p
2N3704/5	10p
2N3706/7	10p
2N3708	10p
2N3773	200p
2N3819	30p
2N3823	30p
2N3866	90p
2N3902	700p
2N3904	15p
2N3906	16p
2N4036	65p
2N4037	65p
2N4123/4	27p
2N4125/6	27p
2N4401/3	25p
2N4427	90p
2N4871	50p
2N5087	27p
2N5089	27p
2N5172	27p
2N5191	90p
2N5245	40p
2N5401	60p
2N5459	30p
2N5460	60p
2N5485	36p
2N5875	250p
2N6027	30p
2N6052	300p
2N6059	325p
2N6107	85p
2N6247	190p
2N6254	130p
2N6290	65p
2SC1306	100p
2SC1307	150p
2SC1957	90p
2SC1969	150p
2SC2028	80p
2SC2029	200p
2SC2078	160p
2SC2335	200p
2SC2612	200p
3N128	120p
3N140	120p
3N141	110p
3N201	110p
3N204	200p
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40361/2	75p
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1N916	7p
1N4148	4p
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1N5

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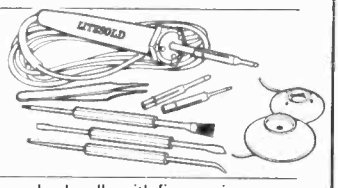
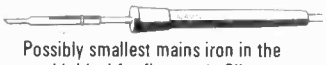
Features spike-free, solid state proportional electronic temperature control inside the handle. Adjustable 280° to 400°C. Burn-proof 3-wire mains lead. Fitted 3.2mm Long-Life bit. 1.6, 2.4 and 4.7mm available. 240v a.c.

SK18 Soldering Kit. £15.24



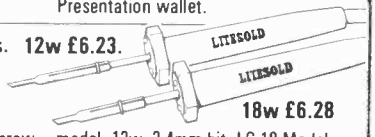
Build or repair any electronic project. LC18 240v 18w iron with 3.2, 2.4, and 1.6mm bits. Pack of 18 swg flux-cored 60/40 solder. Tweezers. 3 soldering aids. Reel of De-Solder braid. In PVC presentation wallet.

ADAMIN Miniature Iron. £5.97



Possibly smallest mains iron in the world. Ideal for fine work. Slim nylon handle with finger grip. Interchangeable bits available 1.2, 1.6, 2.4, 3.4 and 4.7mm. Fitted with 2.4mm. 240v 12w (12v available). Presentation wallet.

'L' Series Lightweight Irons. 12w £6.23.



18w £6.28

High efficiency irons for all electronic hobby work. Non-roll handles with finger guards. Stainless steel element shafts. Screw-connected elements. Slip-on bits available from 1.6 to 4.7mm. LA12 model, 12w, 2.4mm bit. LC 18 Model, 18w, 3.2mm bit. 240v Std – 12v available. Presentation wallet.

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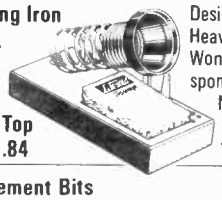

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Designed specially for LITESOLD irons. Heavy, solid-plastic base with non-slip pads. Won't tip over, holds iron safely. With wiping sponge and location for spare (hot) bits. No 5 stand for EC50 iron No 4 stand for ADAMIN miniature Iron No 3 stand for LA12 and LC18 Irons All same price

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For all above irons. Non-stick designs, machined from special copper alloy, with Inconel retaining rings. Two types – Chromium plated with copper face (for economy and ease of use) and Iron plated with Pre-tinned face (Long Life). State tip size, iron and type.

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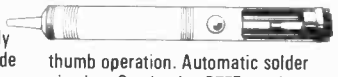
EC50	–	£1.58
Adamin 12 and LA12	92p	£1.56
LC18	£1.01	£1.70

BRADEWICK De-Solder Braid.

£1.05 per Reel

For simple, safe and effective de-soldering of all types of joint, using a standard soldering iron. Handy colour-coded packs of 1.5 metres in 3 widths: Yellow – 1.5mm, Green – 2mm, Blue – 3mm.

De-Solder Pumps. £6.19



High Quality version of increasingly popular type of tool. Precision made anodised aluminium body, plunger guard and high-seal piston. Easy thumb operation. Automatic solder ejection. Conductive PTFE nozzle – no static problems.

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Top quality Japanese metric hardened and tempered tools. Swivel-top chrome plated brass handles. Fitted plastic cases. **113 set** – 6 miniature screwdrivers 0.9 to 3.5mm **£2.70**
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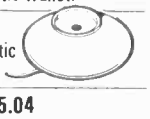
Microcutters. £3.21 Light weight hardened and precision ground. Flush cutting. Screw joint, return spring, cushion-grip handles. Safety wire-retaining clip.

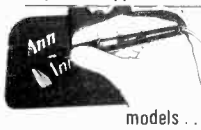
Soldering Aids.

Set of 3 £3.63
Scraper/Knife, Hook/Probe, Brush/Fork. 3 useful double-ended aids to soldering/desoldering/assembly. In plastic wallet.

Solder. £0.90



Top grade resin flux cored 60/40 wire, 18 swg, in handy plastic dispenser. Approximately 3 metres (26gm).



ADAMIN Electric Stylus. £15.04
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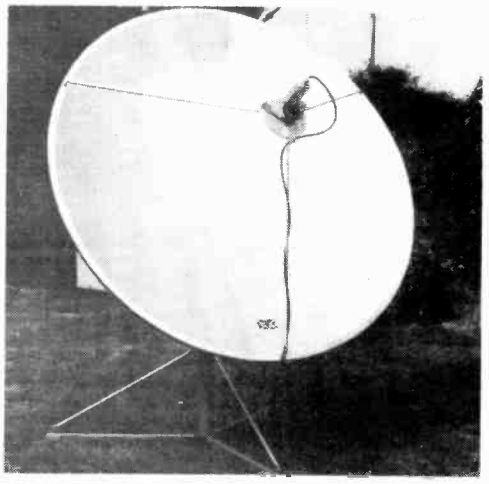

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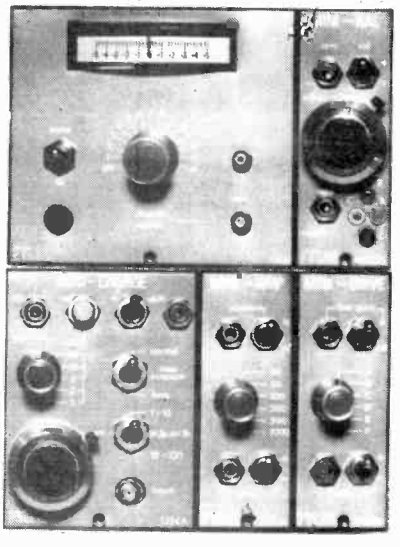

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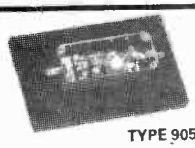
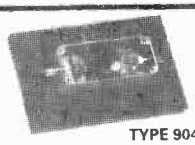


TYPE 9051



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VMOS WIDEBAND LINEAR POWER AMPLIFIERS. 4 watts RF output. Without tuning. Power gain 10 dB. 24V+ supply

TYPE 9046 100 KHz.-100 MHz ..... £64.50+£3.50 p&p
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TELEVISION LINEAR POWER AMPLIFIERS. Tuned to your specified channels in bands IV or V

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TYPE 9152 10 mW. input, 500 mW. output ..... £160+5 p&p
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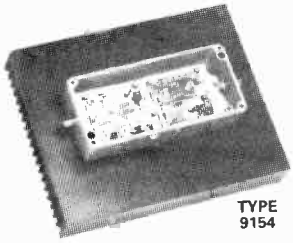
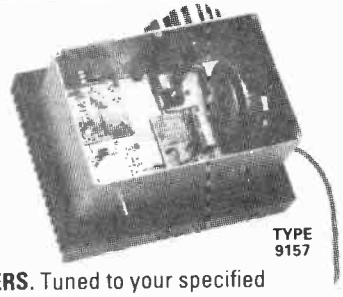


TYPE 9154



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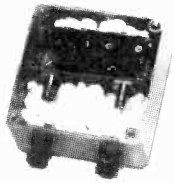

TYPE 9010

TWO STAGE GASFET STRIPLINE PREAMPLIFIERS Tuned to your specified channels in bands IV or V

TYPE 9002 Two stage Gasfet preamplifier. N.F. 0.7 dB. Gain 25 dB. High Q filter. 15V.+ DC ..... £85+£2 p&p
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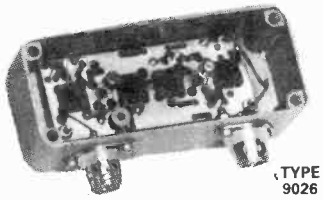
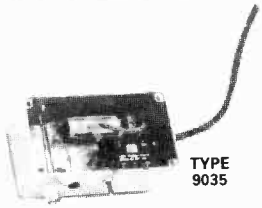
TYPE 9010 Masthead weatherproof unit ..... £6.50+£2 p&p



TYPE 9026



TYPE 9035

GASFET/MOSFET RF PREAMPLIFIERS. Aligned to your specified frequency in the range 30-250 MHz. Masthead/local use

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TYPE 9006 Gasfet. N.F. 0.6 dB. Gain 10-40 dB. variable ..... £65+£2 p&p
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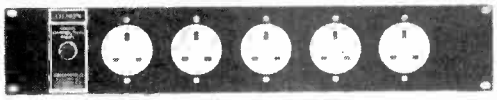

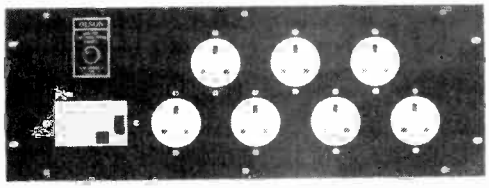

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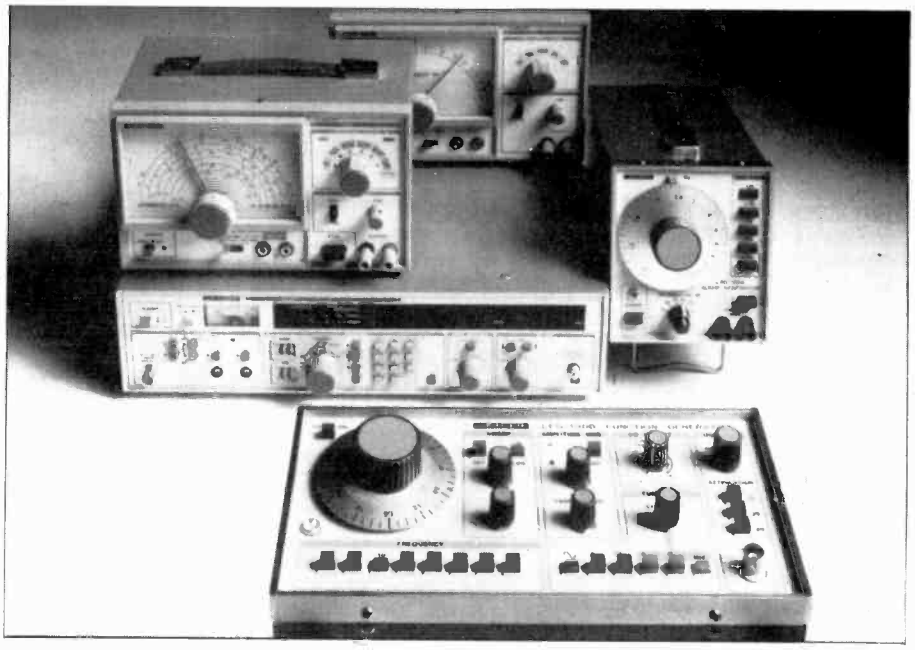

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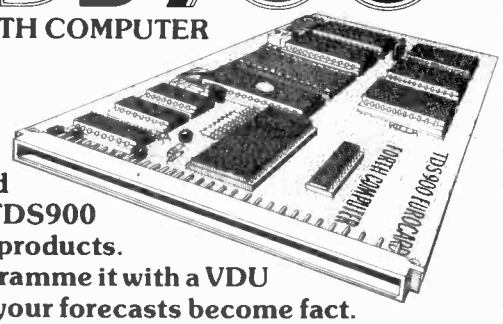
TDS900
FORTH COMPUTER



Build the TDS900 into products. Programme it with a VDU and your forecasts become fact.

Software costs are significant in all industrial applications of microprocessors. They cannot be amortised over the large quantities associated with personal computers and electronic games. This C-MOS embedded computer card aims at resolving this problem by including FORTH high level language programming and developmental facilities. The software can be written quickly and made to work correctly at lowest possible expense. Using a high level programming language rather than assembler gives a fast reaction time to market opportunities. Production products use the same board as employed in the prototypes.

No microprocessor development system is needed since the card contains a screen editor working with simple visual display units (VDUs). It also has the compiler for the FORTH source code. Debugging is inherent in the FORTH language and once the code is working, this can be output to a PROM programmer.

Use of C-MOS throughout has brought the power consumption down to 28mA , making the TDS900 especially suitable for portable and battery-driven applications.

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AA119	0.10	ASZ15	1.20	BC173	0.11	BD132	0.48	BF257	0.27	GEX541	5.00	OA2207	1.50	OC205	2.75	ZTX504	0.21	2N1671	5.00	2N3819	0.30
AAY30	0.17	ASZ16	1.10	BC177	0.28	BD135	0.40	BF258	0.27	GJ3M	1.50	OC16	2.50	OC206	2.75	ZTX531	0.24	2N1893	0.32	2N3820	0.39
AAY30	0.17	ASZ17	1.00	BC178	0.28	BD136	0.40	BF259	0.28	GM0378A	1.75	OC20	2.50	OC207	2.50	ZTX550	0.25	2N2147	4.00	2N3823	0.60
AAZ13	0.15	ASZ20	2.30	BC179	0.28	BD137	0.40	BF336	0.34	KS100A	0.45	OC22	2.50	OCP71	2.00	1N914	0.05	2N2148	3.75	2N3866	1.00
AAZ15	0.15	ASZ21	2.50	BC182	0.11	BD138	0.48	BF337	0.33	MJE340	0.60	OC23	4.00	ORP12	1.00	1N916	0.09	2N2218	0.32	2N3904	0.17
AAZ17	0.15	AU113	2.50	BC183	0.11	BD139	0.48	BF338	0.36	MJE370	0.73	OC24	3.00	R2008B	2.00	1N4001	0.06	2N2219	0.32	2N3905	0.17
AC107	0.55	AUY10	3.00	BC184	0.11	BD140	0.50	BF521	0.20	MJE371	0.71	OC25	1.00	R2009	2.25	1N4002	0.06	2N2220	0.20	2N3906	0.17
AC125	0.25	BA145	0.13	BC212	0.11	BD144	2.00	BF561	0.20	MJE520	0.47	OC26	1.50	R2010B	2.00	1N4003	0.06	2N2221	0.20	2N4058	0.20
AC126	0.25	BA148	0.15	BC213	0.11	BD181	1.20	BF598	0.20	MJE521	0.73	OC28	2.00	T1C44	0.27	1N4004	0.07	2N2222	0.20	2N4059	0.20
AC127	0.25	BA154	0.10	BC214	0.11	BD183	0.80	BFW10	0.97	MJE2955	1.30	OC29	2.00	T1C226D	1.20	1N4005	0.09	2N2223	4.25	2N4060	0.16
AC128	0.30	BA155	0.11	BC237	0.11	BD2137	0.54	BFW11	0.96	MJE3055	1.10	OC35	1.50	T1L209	0.16	1N4006	0.11	2N2368	0.25	2N4061	0.16
AC141	0.28	BA156	0.10	BC238	0.11	BD238	0.54	BFX84	0.30	MPF102	0.35	OC36	1.50	T1P29A	0.43	1N4007	0.12	2N2369A	0.25	2N4062	0.16
AC141K	0.35	BAW62	0.05	BC301	0.33	BDX10	0.91	BFX85	0.30	MPF103	0.35	OC41	0.90	T1P30A	0.45	1N4009	0.07	2N2484	0.25	2N4124	0.16
AC142	0.28	BAX13	0.06	BC303	0.34	BDX32	2.00	BFX87	0.30	MPF104	0.35	OC42	0.90	T1P31A	0.33	1N4148	0.04	2N2646	0.50	2N4126	0.16
AC142K	0.35	BAX16	0.06	BC307	0.11	BDY20	1.50	BFX88	0.30	MPF105	0.35	OC43	1.50	T1P32A	0.36	1N5400	0.13	2N2904	0.32	2N4286	0.15
AC176	0.30	BC107	0.16	BC308	0.11	BDY60	2.75	BFY50	0.25	MPSA06	0.26	OC44	0.85	T1P33A	0.54	1N5401	0.13	2N2905	0.32	2N4288	0.18
AC187	0.28	BC108	0.16	BC327	0.12	BF115	0.35	BFY51	0.25	MPSA56	0.28	OC45	0.65	T1P34A	0.67	1S44	0.04	2N2906	0.21	2N4289	0.18
AC188	0.28	BC109	0.16	BC328	0.12	BF152	0.16	BFY52	0.25	MPSU01	0.53	OC71	0.55	T1P41A	0.44	1S920	0.08	2N2907	0.21	2N4400	0.11
ACY17	1.30	BC113	0.15	BC337	0.12	BF153	0.16	BFY64	0.30	MPSU06	0.65	OC72	1.00	T1P42A	0.42	1S921	0.09	2N2924	0.26	2N4401	0.11
ACY18	1.15	BC114	0.15	BC338	0.12	BF154	0.17	BFY90	0.95	MPSU56	0.69	OC73	1.00	T1P2955	0.70	2G301	1.00	2N2925	0.22	2N4402	0.11
ACY19	1.10	BC115	0.18	BCY30	1.25	BF159	0.17	BSX19	0.27	NE555	0.45	OC74	0.70	T1P3055	0.56	2G302	1.00	2N2926	0.15	2N5457	0.32
ACY20	1.10	BC116	0.19	BCY31	1.50	BF160	0.17	BSX20	0.27	NKT401	3.50	OC75	0.65	T1S43	0.43	2G306	1.00	2N3053	0.26	2N5458	0.32
ACY21	1.15	BC117	0.23	BCY32	1.50	BF167	0.24	BSX21	0.29	NKT403	2.50	OC76	1.00	ZS140	0.25	2N404	1.30	2N3054	0.55	2N5459	0.32
ACY39	2.50	BC118	0.18	BCY33	1.10	BF173	0.30	BT106	1.20	NKT404	2.20	OC77	1.00	ZS170	0.21	2N696	0.32	2N3055	0.65	2S017	10.00
AD149	0.75	BC125	0.18	BCY34	1.00	BF177	0.35	BTY79/400R		OA5	1.20	OC81	0.65	ZS178	0.54	2N697	0.32	2N3440	0.70	2S019	12.00
AD161	0.35	BC126	0.18	BCY39	3.40	BF178	0.35		2.00	OA7	0.60	OC81Z	1.20	ZS271	0.23	2N698	0.32	2N3441	0.85	2S026	25.00
AD162	0.35	BC135	0.15	BCY40	2.80	BF179	0.35	BU205	1.30	OA10	0.55	OC82	0.90	ZS278	0.57	2N705	1.25	2N3442	1.25	2S103	1.50
AF106	0.35	BC136	0.19	BCY42	0.30	BF180	0.28	BU206	1.50	OA47	0.12	OC83	1.00	ZTX107	0.12	2N706	0.25	2N3614	2.20	2S302	2.00
AF114	0.75	BC137	0.19	BCY43	0.30	BF181	0.28	BU208	2.00	OA70	0.25	OC84	0.80	ZTX108	0.12	2N708	0.25	2N3702	0.11	2S303	1.50
AF115	0.75	BC147	0.12	BCY58	0.19	BF182	0.30	BY100	0.40	OA79	0.12	OC122	2.75	ZTX109	0.12	2N930	0.25	2N3703	0.11	2S322	3.50
AF116	0.75	BC148	0.12	BCY70	0.17	BF183	0.28	BY126	0.13	OA81	0.17	OC123	2.00	ZTX300	0.13	2N1131	0.30	2N3704	0.11	2S324	3.50
AF117	0.75	BC149	0.13	BCY71	0.18	BF184	0.28	BY127	0.14	OA85	0.17	OC139	3.00	ZTX301	0.14	2N1132	0.30	2N3705	0.11	2S701	2.00
AF139	0.33	BC157	0.13	BCY72	0.17	BF185	0.30	BZX61	0.17	OA90	0.08	OC140	4.00	ZTX302	0.18	2N1302	1.20	2N3706	0.11	2S745A	0.95
AF186	1.00	BC158	0.13	BCZ11	1.75	BF194	0.14	Series		OA91	0.08	OC141	4.25	ZTX303	0.18	2N1303	0.80	2N3707	0.11	2S746A	0.95
AF239	0.39	BC159	0.13	BD115	0.42	BF195	0.12	BZY88	0.10	OA95	0.08	OC170	1.25	ZTX304	0.20	2N1304	1.20	2N3708	0.10		
AFZ11	4.00	BC167	0.11	BD121	1.70	BF196	0.13	Series		OA200	0.15	OC171	1.25	ZTX311	0.13	2N1305	1.00	2N3709	0.11		
AFZ12	4.00	BC170	0.11	BD123	2.80	BF197	0.14	CRS1/40	0.60	OA202	0.15	OC200	1.50	ZTX314	0.25	2N1306	1.50	2N3710	0.10		
ASY26	1.40	BC171	0.11	BD124	2.00	BF200	0.40	CRS3/40	0.75	OA211	1.50	OC201	2.50	ZTX500	0.14	2N1307	1.10	2N3711	0.10		
ASY27	0.90	BC172	0.11	BD131	0.44	BF224	0.25	CRS3/60	0.90	OAZ200	1.50	OC202	2.75	ZTX501	0.14	2N1308	1.75	2N3771	1.40		
						BF244	0.28	GEX66	3.00	OAZ201	1.50	OC203	3.00	ZTX502	0.18	2N1309	1.20	2N3772	1.60		
										OAZ206	1.50	OC204	3.00	ZTX503	0.19	2N1613	0.32	2N3773	1.80		

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A2087	13.50	E180CC	10.50	EF86	1.75	GXU1	15.35	OZ4	3.50	QY3-125	66.50	UF42	2.10	4-400A	87.00	6CH6	13.00	12AY7A	4.00	5654	3.00
A2134	17.50	E180F	10.20	EF89	2.50	GXU2	30.00	PC86	2.50	QY4-250	68.00	UF80	1.75	4B32	20.00	6CL6	3.75	12B4A	3.50	5651	4.45
A2293	16.00	E182CC	13.25	EF91	2.95	GXU3	25.40	PC88	2.50			UF85	1.75	4C35	78.00	6CW4	8.00	12BA6	2.50	5670	4.50
A2426	27.50	E186F	11.50	EF92	6.37	GXU4	44.50	PC95	1.75	QY4-400	74.20	UF89	2.00	4CX250B	40.00	6D2	1.50	12BE6	2.50	5675	28.00
A2521	22.50	E188CC	8.91	EF93	1.50	GXU50	20.00	PC97	1.75	QY5-500	175.00	UL41	3.50	4CX350A	73.00	6DK6	3.00	12BH7	2.75	5687	6.00
A2900	15.00	E280F	22.51	EF94	2.50	GY501	3.00	PC900	1.75	QY5-3000A		UL84	1.75	4X150A	60.00	6DQ6B	4.75	12BY7	3.00	5696	4.50
A3343	45.00	E283CC	12.00	EF95	5.99	GZ32	4.00	PCC84	1.50		420.00	UM80	2.00	4X150D	56.00	6EA8	3.00	12E1	20.00	5718	7.50
A4241	22.50	E288CC	17.50	EF98	2.00	GZ33	4.75	PCC85	1.50	QZ06-20	32.70	UY41	2.25	5B254M	35.00	6EB8	2.50	12E11TT	28.00	5725	5.50
A4521	22.50	EA52	32.25	EF183	2.00	GZ34	3.00	PCC88	2.00	R10	6.00	UY85	2.25	5B255M	35.00	6EW6	2.25	12E14	65.00	5726	11.37
A2900	15.00	EA76	2.50	EF184	2.00	GZ37	4.75	PCC89	1.75	R17	3.00	VLS631	15.00	5C22	160.00	6F6	3.00	13E1	170.00	5727	7.05
A3343	45.00	EABC80	1.25	EF804S	12.00	KT61	5.00	PCC189	2.50	R18	3.00	XG1-2500	55.00	5J180E	1650.00	6F23	1.60	19H4	27.50	5749	2.50
AZ31	2.75	EAC91	3.50	EF805S	15.00	KT66	12.00	PCC805	1.60	R19	9.24	XG2-6400		5R4GY	3.50	6F28	1.60	19H5	47.50	5751	4.00
AZ41	2.60	EAF42	2.50	EH90	1.75	KT77 Gold Lion		PCC806	1.60	R20	2.50		141.90	5U4G	3.00	6F33	33.50	24B9	67.25	5763	4.50
BK448	114.90	EAF801	2.00	EK90	1.50		9.00	PCE82	2.00	RG3-250	32.68	XG5-500	26.60	5U4GB	2.50	6H1	14.00	30C15	2.00	5814A	4.00
BK484	155.35	EB41	4.00	EL32	2.50	KT88	15.00	PCF80	2.00	RG3-250A	32.68	XG2-6400		5V4G	2.50	6H2N	2.75	30C17	2.00	5840	4.00
BS90	58.00	EB91	1.50	EL33	4.00	KTW61	2.50	PCF82	1.50	RG3-1250	59.50		162.00	5Y3GT	2.50	6H3N	2.75	30C18	2.00	5842	12.00
BS810	60.00	EBC33	2.50	EL34MUI	3.00	KTW62	2.50	PCF86	2.50	RG4-1250	61.60	XR1-1600A		5Z3	4.00	6H6	3.00	30F5	1.60	5876A	31.50
BT5	58.95	EBC41	2.50	EL36	2.50	KTW63	2.50	PCF87	2.00	RG4-3000	99.45		53.75	5Z4G	2.50	6J4	5.50	30FL1/2	1.38	5879	5.00
BT17	151.00	EBC81	1.50	EL41	2.80	M8079	12.34	PCF200	3.25	RR3-250	40.00	XR1-3200	81.97	5Z4GT	2.50	6J6	8.93	30FL12	1.80	5886	15.00
BT19	44.05	EBC90	1.25	EL42	2.50	M8080	8.25	PCF201	3.25	RR3-1250	45.75	XR1-3200A		6-30L2	1.75	6J7	4.75	30FL14	2.00	5963	2.50
BT29	349.15	EBF80	1.50	EL81	5.25	M8081	9.82	PCF801	2.50	S11E12	65.00	XR1-6400		6AB4	1.75	6K4N	2.50	30L1	1.50	5965	3.50
BT69	354.80	EBF83	1.75	EL83	6.00	M8082	9.69	PCF802	2.50	S130	6.00		102.00	6AB7	3.00	6K6GT	2.75	30L15	2.00	6005	2.25
BT95	129.90	EBF89	1.50	EL84	2.25	M8083	8.58	PCF805	1.70	S130P	6.00	YD1120	395.00	6AC7	3.00	6K7	3.00	30L17	2.00	6021	4.50
CBL31	4.00	EBL31	4.00	EL86	2.75	M8091	10.43	PCF806	1.70	STV280-40		YD1240	450.00	6AF4A	4.25	6K8	3.00	30P4	2.50	6057	10.23
CL33	4.00	EC90	1.25	EL90	2.25	M8096	6.80	PCF808	1.70		14.00	Z759	25.00	6AG7	3.00	6KD6	7.00	30P19	2.50	6058	12.34
CY31	3.00	EC91	8.00	EL91	9.69	M8097	8.10	PCL82	2.00	STV280-80		ZM1000	8.00	6AG8	5.00	6L6G	3.00	30PL1	3.00	6059	6.00
C1K	20.00	EC92	1.75	EL95	2.00	M8098	6.15	PCL83	3.00		21.00	ZM1001	8.00	6AK5	5.99	6L6GA	3.00	30PL14	1.80	6061	6.00
C3A	22.00	EC157	380.00	EL156	30.00	M8099	8.00	PCL84	2.00	SU41	5.00	ZM1020	9.00	6AK6	2.50	6L6GC	3.00	30PL15	1.80	6063	3.75
C3JA	22.00	ECC33	4.50	EL360	8.50	M8100	9.52	PCL85	2.50	SU42	10.00	ZM1021	9.00	6AL5	1.50	6L6GT	3.00	35W4	1.00	6064	8.58
DA41	25.00	ECC35	4.50	EL500/504	3.00	M8136	10.23	PCL86	2.50	TD03-10	35.00	ZM1022	9.00	6AM4	4.00	6L7	2.50	50C5	1.50	6067	10.23
DA42	18.70	ECC40	4.50	EL509	7.00	M8137	10.23	PCL805/85	2.50	TD03-10F	35.00	ZM1023	9.00	6AM5	9.69	6N2P	2.50	75B1	6.05	6072	6.00
DAF91	1.75	ECC81	1.75	EL821	13.00	M8140	6.00	PD500	6.00	TT15	35.00	ZM1040	19.36	6AM6	6.02	6N3P	2.50	75C1	4.50	6080	14.00
DAF96	1.75	ECC82	1.75	EL822	13.97	M8141	6.50	PE06-40N	45.00	TT21	23.00	ZM1041	16.66	6AN5	4.75	6N7	3.00	85A1	7.50	6097A	235.00
DET22	35.00	ECC83	1.75	EM34	5.00	M8142	8.75	PFL200	2.50	TT22	23.00	ZM1042	17.77	6AN8A	3.50	6P25	4.00	85A2	4.45	6097B	200.00
DET24	49.00	ECC84	1.75	EM80	2.50	M8144	7.50	PL36	2.50	TT100	60.00	1B3GT	3.00	6AQ5	2.25	6Q7	3.75	90AG	12.96	6146A	8.25
DF91	1.75	ECC85	1.75	EM81	2.50	M8149	6.50	PL81	1.75	TY2-125	65.00	1B24	25.00	6AS6	8.66	6R7	3.25	90AV	12.96	6146B	8.25
DF96	1.75	ECC86	2.50	EM84	2.00	M8161	9.35	PL81A	2.00	TY4-400	75.00	1B35A	48.00	6AS7G	8.75	6SA7	3.00	90C1	6.00	6159B	19.00
DK91	1.75	ECC88	2.10	EM85	2.75	M8162	10.40	PL82	1.50	TY4-500	98.35	1B63	64.00	6AT6	1.25	6SC7	2.75	90CG	14.54	6189	9.50
DK92	2.00	ECC89	2.00	EM87	2.50	M8163	8.25	PL83	2.50	TY5-500	201.50	1R5	1.75	6AU5GT	5.00	6SF7	2.50	90CV	15.45	6201	11.40
DK96	1.75	ECC91	8.93	EN32	17.46	M8190	5.00	PL84	2.00	TY6-800	196.50	1S5	1.75	6AU6	2.50	6SH7	3.00	92AG	12.96	6442	20.00
DL92	2.00	ECC189	2.10	EN91	£7.05	M8195	10.85	PL504/5	2.50	TY6-5000A		1T4	1.75	6AV5GA	4.50	6SJ7	3.25	92AV	12.96	6883B	8.25
DL94	1.75	ECC807	1.75	EN92	6.96	M8196	7.50	PL508	2.50		490.00	2AS15	11.50	6AV6	1.50	6SK7	3.50	95A1	8.45	6973	4.00
DL96	1.75	ECC808	3.00	EY51	2.75	M8204	7.05	PL509	6.00	TY6-5000B		2C39A	60.00	6AX5GT	3.00	6SL7GT	3.00	150B2	6.50	7025	3.00
DLS15	12.50	ECF80	1.55	EY81	2.50	M8212	11.37	PL519	6.00		395.00	2C43	70.00	6B7	3.25	6SN7GT	3.00	150B3	8.35	7551	6.25
DLS16	12.50	ECF82	1.50	EY83	2.50	M8223	6.00	PL801	1.50	TY6-5000W		2D21	3.25	6B8	3.25	6SQ7	3.40	150C2	3.25	7586	12.00
DLS19	12.50	ECF86	2.50	EY84	9.24	M8224	6.30	PL802	6.00		407.00	2E26	8.25	6BA6	1.50	6SR7	4.00	150C4	6.00	7587	18.50
DM70	2.00	ECH35	3.00	EY86	1.75	M8225	4.50	PY33	2.50	TY7-6000A		2J42	98.00	6BA7	5.00	6SS7	2.75	211	35.00	7609	56.00
DM71	2.00	ECH42	3.50	EY88	1.75	M8248	14.03	PY81	1.50		485.00	2J55	175.00	6BA8A	4.00	6U5G	3.50	723AB	125.00	7868	6.00
DM160	4.75	ECH81	3.00	EY500A	3.00	MD2901	115.00	PY82	1.50	TY7-6000W		2J70A	383.00	6BC4	4.00	6U8A	2.25	803	25.00	7895	12.00
DY87	1.50	ECH83	2.50	EY802	1.75	MU14	2.50	PY83	2.50		303.60	2J70B	336.00	6BE6	1.50	6V6GT	2.25	805	45.00	8005	110.49
DY802	1.50	ECH84	2.50	EZ35	1.75	MX119	55.00	PY88	2.00	TZ40	25.00	2K25	125.00	6BH6	2.50	6X4	2.00	807	3.75	8068	14.00
E55L	22.00	ECL80	-1.50	EZ40	2.50	MX123	72.00	PY500A	4.00	U18-20	3.50	3-400Z	85.00	6BJ6	2.25	6X5GT	1.75	811A	18.33	8122	90.00
E80CC	8.81	ECL81	1.75	EZ41	2.50	MX145	56.70	PY800	1.50	U19	13.75	3-500Z	85.00	6BK4	4.50	7B7	2.50	812A	18.33	8136	2.50
E80CF	11.27	ECL82	1.50	EZ80	1.50	MX151	17.25	PY801	1.50	U25	2.50	3A5	3.00	6BL6	85.00	7C5	4.00	813	125.86	8417	6.00
E80F	14.19	ECL83	3.00	EZ81	1.50	MX152	131.25	QQV02-6	30.50	U26	2.50	3B24	11.00	6BL7GT	4.50	7C6	2.50	833A	193.16	18042	11.53
E80L	13.73	ECL84	1.50	EZ90	2.00	MX161	152.25	QQV03-10	20.50	U37	12.00	3B28	15.35	6BM6	115.00	7H7	4.00	866A	20.03	18045	10.49
E81CC	8.00	ECL85	1.50	FW4-500	3.50	MX163	20.25	QQV03-20A		UABC80	1.25	3B29	20.05	6BN6	2.00	7R7	4.25	872A	20.00		
E81L	13.27	ECL86	1.75	FW4-800	3.50	MX164	25.52		48.38	UAF42	2.50	3B240M	17.50	6BQ7A	3.50	7S7	3.50	922	6.00	Tested	
E82CC	8.10	EF37A	5.00	G1.371K	35.00	MX166	147.00	QQV06-40A		UBL1	3.00	3B241M	17.50	6BR7	6.00	7Y4	2.25	931A	18.50	Ex-Equipment	
E83CC	8.40	EF39	2.75	G551K	12.00	MX168	50.00		65.34	UBC41	2.25	3C23	25.00	6BR8A	3.50	7Z4	2.00	812A	18.33	4CX250B	6.50
E86C	8.25	EF40	5.00	G180.2M	17.50	N78	15.00	QQV07-50	68.60	UBF89	1.50	3C45	24.50	6BS7	6.00	11E3	55.00	813	125.86		
E88C	8.25	EF41	3.50	G240.2D	12.00	OA2	3.25	QQZ06-40A		UCC84	1.75	3CX100A5		6BW6	6.00	12AH8	5.00	833A	193.16		
E88CC	8.42	EF42	4.50	G400.1K	17.50	OA3	2.50		62.20	UCC85	1.85		47.00	6BW7	1.50	12AT6	1.50	866A	20.03		
E90CC	9.47	EF50	2.50	GN4	9.00	OA4	6.00	QU37	12.50	UCF80	2.00	3E29	45.00	6BX7GT	5.00	12AT7	1.75	872A	20.00		
E90F	9.90	EF54	5.00	GN4A	9.00	OB2	4.35	QV03-12	6.80	UCH42	2.50	3S4	2.00	6BZ6	2.75	12AU6	2.50	922	6.00		
E91H	6.25	EF55	3.50	GS16	16.00	OB3	2.50	QV04-7	3.50	UCH81	2.50	3V4	1.75	6C4	1.25	12AU7	1.75	931A	18.50		
E92CC	8.75	EF80	1.75	GT1C	15.00	OC2	4.35	QV08-100		UCL82	1.75	465A	60.00	6CB6A	2.50	12AV6	2.50	1624	4.00		
E99F	9.10	EF83	4.00	GU50	20.00	OC3	2.50		155.70	UCL83	2.75	4-125A	60.00	6CD6GA	5.00	12AV7	3.50	1625	3.50		
																		2050	7.50		
																		4212E	300.00		
																		4212H	300.00		
																		5544	81.97		
																		5545	102.00		
																		5551A	114.90		
																		5552A	155.35		

BASES

B7G unskirted	0.22
B7G skirted	0.30
B9A unskirted	0.22
B9A skirted	0.30
Int Octal	0.35
Loctal	0.55
Nuvistor base	0.75
8 pin DIL	0.10
14 pin DIL	0.10
16 pin DIL	0.10
Valve screening cans all sizes	0.30

CRTs

2AP1	8.50
2BP1	9.00
3BP1	12.00
3DP1	5.00
3EG1	10.00
3FP7	6.00
3GP1	6.00
3JP1	8.00
3JP2	8.00
3JP7	10.00
3KP1	15.00
3RP1	35.00
3WP1	20.00
5ADP1	35.00
5CP1	10.00
5CP1A	40.00
5FP15A	15.00
5UP7	25.00
DG7-5	63.32
DG7-31	58.07
DG7-32	58.07
DH3-91	56.83
DH7-11	113.12
VCR97	12.00
VCR138	12.00
VCR138A	12.50
VCR139A	8.00
VCR517A	10.00
VCR517B	10.00
VCR517C	10.00

Tube Bases Prices on application

INTEGRATED CIRCUITS

7400	0.16	7423	0.33	7460	0.18	7495	0.73	74136	0.51	74175	1.02	TBA520Q	2.30						
7401	0.17	7425	0.30	7470	0.38	7496	0.82	74141	0.89	74176	1.16	TBA530	1.98						
7402	0.17	7427	0.30	7472	0.33	7497	3.15	74142	2.30	74178	1.36	TBA540Q	2.30						
7403	0.17	7428	0.43	7473	0.38	74100	1.54	74143	2.60	74179	1.36	TBA550Q	3.22						
7404	0.18	7430	0.17	7474	0.38	74107	0.45	74144	2.60	74180	1.20	TBA560CQ	3.22						
7405	0.18	7432	0.30	7475	0.54	74109	0.73	74145	1.00	74190	1.90	TBA673	2.20						
7406	0.43	7433	0.40	7476	0.42	74110	0.51	74147	2.00	74191	1.90	TBA700	1.52						
7407	0.43	7437	0.32	7480	0.56	74111	0.71	74148	1.76	74192	1.90	TBA720Q	2.30						
7408	0.20	7438	0.32

AFFORDABLE PERIPHERALS.

Opus peripherals are the best buys in the whole peripherals market–bar none.

Just compare the prices below with anything else in this magazine. And note just what our prices include: VAT, all necessary leads, carriage and a full one year's guarantee.

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Opus 3402 Double Sided 40 Track Drive ½ Megabyte Unformatted.

- Twice the capacity on line of other available drives
- 200K Single Density–400K. Double Density
- Ex-stock delivery • 3ms. access time
- Lowest power consumption–direct drive
- Includes case, leads and utilities disc
- Totally compatible with 5¼" drives

Single Drive. ____ **£229.95**
Dual Drive. ____ **£459.95**

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Opus 5401 Single Sided 40 Track–250k. Unformatted. Formatted: 100K. Single Density. 200K. Double Density. ____ **£179.95**
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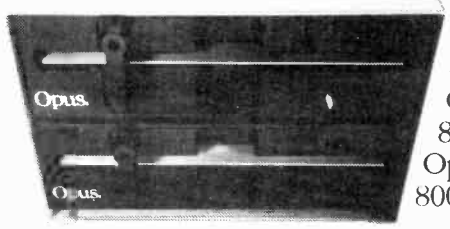
Opus 5802 Double Sided 80 Track–1 Megabyte Unformatted. Formatted: 800K. Single Density, Switchable 80/40 Track. ____ **£299.95**

• ½ Height • Includes case, leads and utilities disc • Fast access time • State of the Art Technology • Ex-stock delivery • Low power consumption.

DUAL DRIVES.



All Dual Drives are metal cased with separate power supply.
Opus Dual 540ID. Single Sided 40 Track. 200K./400K. on line. ____ **£379.50**
Opus Dual 5402D. Double Sided 40 Track. 400K./800K. on line. ____ **£459.95**
Opus Dual 5800 Double Sided 80 Track. 800K./1.6 Megabyte on line. ____ **£499.95**
Opus Dual 5802D. Double Sided 80 Track. 800K/1.6 Megabyte on line. Switchable 80/40 Track. ____ **£599.95**

FLOPPY DISCS. DOUBLE DENSITY FILING SYSTEM.

3" Cartridge **£5.75** each or **£25.95** for 5.

5¼" Discs with full 5 year warranty + free plastic library case.
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S/SD/D **£23.95** for 10.
D/SD/D **£26.95** for 10.

S/S 80 Track **£29.00** for 10.
D/S 80 Track **£31.95** for 10.

8" Discs.
S/SS/D **£21.50**
S/SD/D **£28.50**
D/SD/D **£29.95**

Double Density filing system. **£100.00**

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High Resolution (580 × 470 pixels) and
Medium Resolution (370 × 470 pixels) Models available.

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- RGB Analogue/TTL input
- 80 Characters × 25 lines
- EHT: Min: 19.5kv MAX 22.5kv
- Supply–220/240v 50/60Hz

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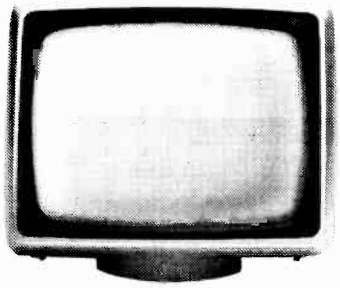
Medium Resolution Model ____ **£187.39**



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Superb units, optimised for high resolution and excellent geometry.

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- 800 lines horizontal at centre
- EHT 13.0kv • Supply 220–240V.

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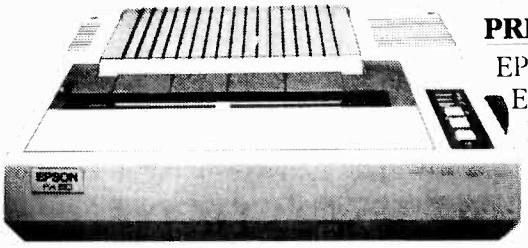
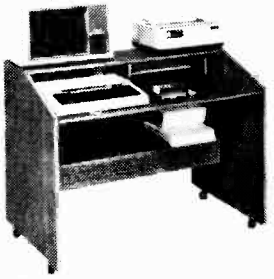
Amber Screen ____ **£99.95**



PRINTERS.

EPSON FX80 F/T ____ **£410.00**
EPSON FX 100 ____ **£549.00**
EPSON RX80 F/T ____ **£315.00**
JUKI 6100 Daisywheel ____ **£435.00**
Parallel printer leads to BBC ____ **£13.50**

THE ORGANISER DESK.



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- Self Assembly
- Ample room in front of the shelf for you to sit comfortably
- Assembled Dimensions: H.31" W. 40¼" D. 26" Only **£59.95**

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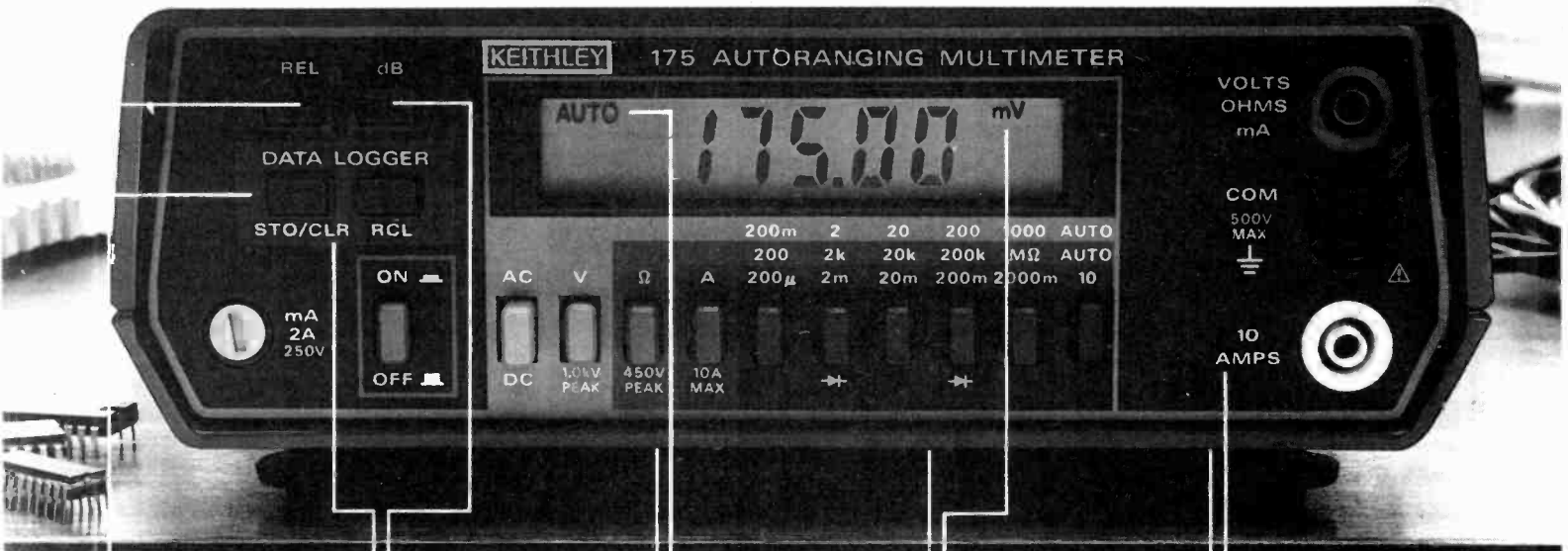
Keithley's 175.



Data Logger — **Relative Reference**

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Software copyright and piracy

The issue of software copyright is a vexed and intractable one. On the one hand, there is the undoubted need to provide a living for programmers and maximum distribution of valuable software. On the other hand, one must consider that software is not an art form and can be derived independently from situation logic; furthermore, if a processor contains many equivalent registers, any change in the use of registers means a new program, therefore people desirous of stealing the work of a programmer for commercial gain and having the time to do it and the backup to pay lawyers, presumably can. As Dean Swift pointed out, that the lawyer is interested in "whether the said cow be black or white" not in what title the claimant has to the cow.

There are two alternatives to ensure a proper return. Either every user must pay a fee to the inventor of the program, or the state must use the award-to-inventor system. Attempts have been made to shame users into the former course by writing on software packages the fact that the programmer must live and asking all users to buy their own expensive copy, for the fact is that popular material will always tend to be expensive, providing quite unjustified returns, like a best-selling book, while the minority-interest material will with the greatest difficulty recover costs. A book or program concerned with sewage cannot sell more copies than there are sewage works, yet may affect the lives of every citizen. Thus authorship of all kinds is grossly ill-rewarded by the commercial system.

This problem is entirely new, because in the past technical authors might be reasonably expected to have academic jobs and programs be published free. There is no way that the cottage industry of software production can protect its copyright. It must rely on honourable treatment. If it doesn't get it and if as a nation we want this industry to continue we will have to pay the workers from central funds.

This will distress the computer retail industry who naturally want to sell information in a physical object with a limited life and accident prone condition, like a paperback book.

Anyone who wants to pirate a very valuable program need only buy enough battery backed-up ram to hold it, for there is no way anyone can argue that software can't be copied into ram: similarly it would be very hard to argue that paper tape cannot be cut from this ram.

If one uses selective-bit inversion no one could ever prove a tape was their program; it is foolish to contemplate it. In the end people will pay for convenience if the software creators aren't greedy and shops take reasonable mark-ups. Blatant commercial pirates ought to be prosecuted, but talk of prosecuting friends for exchanging one's own copies is nonsense.

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COMMUNICATIONS

History in the making

Apart from those few radio and television pioneers who are regarded by the public as the great inventors – Marconi, Armstrong, Baird, Watson-Watt etc. – the bulk of engineers and scientists who have followed in their wake and contributed enormously to the technology have remained virtually unrecognised. Few engineers, let alone the public, associate the coaxial cable with Franklyn, the waveguide with Southworth, the optical fibre pipe with Kao . . . etc. Very few engineers write readable autobiographies, fewer still form the subject of in-depth studies by historians who can appreciate the precise value of the contributions they made to the state-of-art.

Occasionally one comes across exhortations to technologists such as "It isn't enough in any science to do things. It is necessary to communicate what has been done . . . not only your scientific or engineering results but also talk about how they arose, who was involved, all those things that are too often unrecorded. People's memories are not precise. But that does not matter because the essence of historical scholarship is to use memoirs and other primary sources with discretion. A person who has participated shouldn't worry about that bias he has due to his participation. The historians will take care of that in due time by comparing sources and checking dates."

Excellent advice – provided always that those later historians actually start digging, and manage to produce books that can be read with interest!

These thoughts have been generated by reading two recent exceptions to the general rule: Dr George Brown's lively and outspoken recollections of his life as a research engineer "and part of which I was" (Angus Cupar Publishers) that covers not only his pioneer work on aerials, r.f. heating and colour television but the familiar problems of an engineer caught up in commercial and political struggles to gain acceptance for his ideas. The second book was Andrew Hodges' excellent 600-page study of "Alan Turing – The Enigma" (Burnett Books, 1983) that provides a detailed study of the life and tragic early death of the brilliant mathematician who in 1936 first outlined the concept of the 'universal machine' from which was to spring the digital computer. He was a gifted member of that formidable team of cryptoanalysts who in the "creative anarchy" of Bletchley Park successfully tackled the difficult German naval enigma machine code; taught himself electronic and radio engineering in a couple of months at Hanslope Park; and struggled at NPL to get built the stored program computer ACE but found bureaucracy too strongly entrenched. In fairness to NPL, Turing was clearly not the easiest or most diplomatic person to work in harness with, though capable of attracting intense loyalty from those who assisted him during wartime.

A few years ago I received a letter from a technician who had worked alongside Turing at Hanslope when, with Donald Bayley, he was developing the never-to-be-used Delilah speech encryption system. Alan Turing was then advising the whole laboratory on circuit calculations, he had picked up practical radio engineering in less than three months, claiming "When I first looked at radio I could see it was 100% mathematics anyway so it was no problem."

Andrew Hodges has amassed an enormous amount of information on Turing, but the reason for his suicide in June 1954 remains a mystery. Hodges shows that the often-mentioned prosecution of Turing on homosexual charges was by then two years behind him. He speculates on the continued involvement of Turing with GCHQ in an era when the security investigations following the Burgess, MacLean, the third and fourth man scandals were still rumbling on, but provides no evidence of any link between these events and Turing's untimely death. Certainly there can be no evidence that Turing, patriot that he was, was ever a real security risk.

NTSC, PAL and SECAM

Dr Brown is particularly revealing about the bitter struggle in the period 1945-1955 between RCA and CBS over the sequential and compatible colour television systems, and the subsequent struggle in Europe over NTSC (which was basically the RCA system), PAL and SECAM. He shows clearly, though from an American viewpoint, that politics rather than engineering dominated the CCIR meetings at Vienna and Oslo, and the similarity of Russian, American, French and British skulduggery in the form of overnight changes of policy, suppression of technical reports, rigging of delegations and the like. As one retired British television engineer put it to me, in recommending George Brown's lively account of his struggles with RCA's management, "Just change the name of the firm, and you have the story of my life". For any young engineer who wishes to understand how things really happen, this is essential reading – though I noted that even the politically-conscious Dr Brown apparently failed to note one of the most astonishing events of the Oslo CCIR meeting in 1966 . In April of that year, a member of the British delegation returned (unsuccessfully) to the UK during the event for the express purpose of trying to have the Post Office man in charge of the British delegation removed, leading later to an off-the-record press briefing in which the leader of the British team bitterly attacked the broadcasting delegates.

Data security

Presumably we shall never know whether Turing was under pressure from the security people in 1954 though one has no doubt that, as a wartime member of the Government School of Codes and Ciphers, he would have figured in those secret files that will remain inviolate under both the 30-year rule and the Data Protection Bill. Yet there is plenty of evidence that such files frequently contain information confused by mistaken identification etc. This might not matter so much were it not for the evidence that the Security Service advise outside organizations, including commercial firms, when recruiting engineers for sensitive posts. With such information now fully computerized, the effects on people's careers can be far-reaching. Unlike many other countries not even the registrar, who will administer the British Act, will have power of inspection or supervision of either security or police files.

Clandestine war plans

Surprisingly one of the official files of 1953 now opened under the 30-year-rule details plans then proposed for clandestine activities in the event of war. The 1982 Falklands campaign showed that such activities still form an important part of British military planning. The 1953 proposals covered "stay-behind", evader and coup-de-main activities. Sir John Sinclair, then head of the Special Intelligence Service, requested the use of 15 fast patrol boats, three trawlers, 42 fishing boats, 8 long-range aircraft, use of a submarine, and no less than 400 specially trained signals operators. Britain, France and the USA were each expected to provide 500 agents and 50 aircraft for the first three weeks following the outbreak of war. It was recognized that such activities were a gamble, possibly paying a high dividend or "next to none". One wonders if the agents knew that they were to be part of a high risk gamble.

Costly clangers

Governments can and do make bad mistakes on their assessment of new electronics technology in addition to grossly underestimating the development costs. Now, the French Government and their nationalised Elf-Aquitaine oil company has been forced into revealing that they were "taken" to the tune of some £60million by the so-called Omega and Delta oil-sniffing systems that purported to reveal deeply buried geological strata to aircraft flying overhead, but was eventually shown to depend on prepared sketches fed into the machine. By surrounding the invention with an air of mystery, the Panamanian-registered company, Fisalma, was able to block all attempts to examine the costly prototypes. But it is not only the French

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COMMENTARY

Government that has been known to back the wrong horse in electronics and telecommunications.

Recently Americans have become increasingly uneasy that the electronics equipment put into military aircraft, flight simulators etc can cost up to ten times its civilian counterpart. The electronics can cost many times more than basic aircraft. As one writer put it recently: "In the necessary secrecy that shrouds weapons development, a pipe dream can be pursued for years – and for billions of dollars – before someone catches on to its futility." The solution, it is suggested, would be to introduce independent technical monitoring of projects by a watchdog committee of top-notch engineers. But, one wonders, who would watch the watch-dogs? Engineers, as well as administrators, have been known to get it wrong.

The AM-stereo struggle

At the end of 1983 there was still no clear outcome to the "market-place" struggle in the USA between the four competing systems of a.m. stereo. In terms of transmitters, Harris had lost the lead to Kahn's independent sideband system used by some 80 stations including several major NBC music stations. Harris was stuck at about 65 stations, resulting from the FCC decision to restrain the company from marketing any more exciters until the type-acceptance dispute had been fully cleared up. Motorola was up to about 50 and their system has been endorsed by some large car radio firms. Trailing with single-figures was the Magnavox system, despite it being the original choice of FCC in 1979. Meanwhile Sony has marketed a $90 combined a.m./f.m. portable that can receive any of the four a.m.-stereo systems and including a switch to widen the m.f. bandwidth to 12kHz. A multimode set has also been marketed by Sansui.

AMATEUR RADIO

50MHz extension

The Department of Trade and Industry has agreed to a substantial extension of the special research permits for 50MHz operation by British amateurs holding Class A licences. The number will go from 40 to 100. DTI have asked the RSGB to recommend additional names by March 31. With all British 405-line television broadcasting in bands 1 and 3 now due to end in the first week of January 1985, British amateurs are hoping that the DTI will make an early announcement about any plans to implement the recommendation in the interim Merriman Report in 1982 that an allocation in this part of the spectrum should be made available to all British amateurs. There remains the problem that this part of the frequency spectrum (except channel 1) is likely to remain in use for television in virtually all other European countries.

RTTY

Ian Wade, G3NRW, the current editor of the British Amateur Radio Teleprinter Group newsletter, estimates that about one half of BARTG members are still using mechanical teleprinters but many are in process of adopting computer-based the electronic systems with over two-thirds of the membership owning home computers. Interest in the Amtor system with automatic correction of errors is also increasing rapidly and expected to really take off during 1984 with commercially manufactured units increasingly available. He also forecasts more amateur interest in digital data techniques including the"packet" systems. But there seems to be no end in sight to various problems of different technical standards, including the long standing problem of 45 versus 50 baud transmission, though some teleprinters, such as the Creed 444 will cope with both speeds. Bob Sayers, G8IYK is seeking contact with radio amateurs interested in adapting compact telephone-line facsimile equipments for h.f. transmission or for using such machines for other applications. He also points out that a special Met Office licence is needed to receive weather messages in r.t.t.y. format. Application forms for DTI licences can be obtained from Meterological Office (Licensing) London Road, Bracknell, Berks, RG12 2SZ. Full title of the licence is "Receiving licence for the reception of meterological information transmitted from special service stations".

During 1984 BARTG celebrates its Silver Jubilee having been founded in 1959. The group caters for those interested in most forms of data transmission, including r.t.t.y., Amtor, Fax, weather forecasting, satellites and telemetry. Current membership is about 1300. Membership details from John Beedie, G6MOK, 161 Tudor Road, Hayes, Middlesex UB3 2QG (telephone 01-561 0010). Apart from the quarterly newsletter BARTG publish "RTTY, the easy way".

Low power activity

Although extreme low-power operation is not an activity I would recommend to newcomers to the h.f. bands, it holds much interest for those with the necessary experience and patience. Indeed on some h.f. bands signals can come in at good strength from transmitters using power inputs of less than 5 watts over many thousands of miles. Low-power (QRP) operation in the UK has for a number of years been encouraged by the "G-QRP Club", formed in late-1974, and now having almost 2500 members. Rev George Dobbs, G3RJV, editor of its quarterly journal "Sprat" admits to being concerned that the fall-off of conditions on the h.f. bands due to the declining sunspot activity may make it more difficult to achieve good contacts on the higher of the h.f. bands but urges more activity on the "low-power calling frequencies" of 3560kHz and 7030kHz. He notes that low-power operation on these bands has not kept pace with the increasing number of members. He reports, however, an increasing interest in home construction of low power transmitters and compact direct-conversion receivers.

In brief . . .

George Stratton Loughton, founder in the 1920s of Eddystone Radio, died during December 1983. Eddystone was one of the first British firms to cater specifically for short-wave enthusiasts and radio amateurs with their "All World" series of receivers and components for home construction . . . RSGB membership has exceeded 35,000 for the first time . . . The RSGB National VHF convention is being held on March 24 at Sandown Park Racecourse, Esher, Surrey . . . A mobile rally is being held at the Carelton Community Centre by the Pontefract society on March 18 . . . An increasing number of amateurs in many parts of the world are now equipped for earth-moon-earth (moonbounce) contacts on the 1.3 and 2.3GHz band but Z25JJ, representing Africa, is closed for the time being while his equipment, including a massive 32ft dish reflector, is transported from Zimbabwe to South Africa . . . Much effort is being put into the rush building at the University of Surrey of its second spacecraft, UOSAT-B, which it hoped will be launched this Spring . . . Of the various Russian amateur satellites, RS6 and RS8 remain in operation. The problem on the L-band Oscar 10 transponder seems to have been successfully overcome . . . The IARU Region 1 Triennial Conference, bringing together the national IARU societies in Europe and Africa, is to be held in Sicily between April 7 and 14 . . . The installation of the RSGB's 50th President, R. G. Barrett, GW8HEZ, was at Cardiff Castle on January 14 . . . A number of changes affecting the British CB licence were introduced on February 1. No further licences are being issued to persons under 14 years of age but they can operate CB equipment under supervision. There is now an explicit ban on the playing of music and the re-transmission of radio and television broadcast material (both of which have always been illegal) and DTI draw attention to the CB Code of Practice in particular highlighting the recommendation that Channel 9 should be used for emergencies and assistance only.

PAT HAWKER, G3VA

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Adaptable typewriter interface

Simple interface connects electronic typewriter to computer parallel output port. Self-documenting Pascal code facilitates translation into other languages that might be used in the target processor, and demonstrates how a printing routine is constructed rather than provides a rigid routine for only one situation.

by
C. M. Fortescue-Webb M.Sc.

Acquisition of a home-based computer requires a decision as to the type of printed output needed. The provision of a fully-formed letter printer allows a system to be used for word processing with a degree of professionalism that is absent from the usual low-definition dot-matrix machine. If an electronic typewriter is availble then the simple interface described here enables it to be driven from a Centronics or other parallel output port.

The interface is in principle applicable to any typewriter mechanism that uses electronic-style switches to complete a circuit when a key is depressed. Virtually all daisy wheel printers use this type of mechanism. Since the majority of small computer systems do not have printer spooling (i.e. the system is dedicated to driving the printer whilst the printer is active) the computer is used to provide as much as possible of the intelligence of the interface.

Although the interface itself is simple it is necessary to do some investigation to determine the correct connection points for the various wires – and then further work to find the correct data for each printed character. The interface was actually connected to an Olivetti Praxis 35 and the specific data as to connection points and character data refer to this machine. Enough information is included to enable adaption to any other machine.

General considerations

In operation the printer sequentially grounds one of the lines marked A through H and reads the data appearing on all the lines a through h, Fig. 1. If no keys are closed then the data will be read as all high but otherwise the occurence of a low will allow the closed key to be detected and decoded. Two points about this – first, a number of reads must give the same data for the printer to register the key closure and to avoid errors due to contact bounce. Second, not all possible crossing points on the matrix are used and so there are a number of possible data codes that may have no meaning to the printer as they should not be generated by the keyboard. Also there are two connections outside the matrix (I to i and J to j) used to tell the printer about keys that are pressed in conjunction with the main keyboard. Examples of this on the Praxis are Shift and Keyboard 1 or Keyboard 2.

To simulate a key closure the circuit of Fig. 2 could be used. When the select key line is true then the low-going pulse on the input line be coupled through to the output. By using open collector gates there will be no interaction between the various keys. The difficulty of such a scheme is that a key select line is needed for every key and this requires a lot of hardware. By using a multiplexer and demultiplexer coupled with open collector drivers the final arrangement shown in Fig. 3 is realised. Now three lines are used to select the input row and a further three to select the output column. The remaining two lines on the eight-line computer output are used for the shift and keyboard 1/2 switches. Incidentally, if your computer will only output a seven-bit character on the parallel port then the keyboard 1/2 or equivalent line will have to be operated manually.

It is also necessary to prevent the computer passing data to the printer at a rate in excess of that at which it can accept the data. The interface shown here uses a software delay loop in the driving routine to ensure that the character rate is within specifications. A longer delay is used for those functions on the typewriter that take longest – carriage return (up to two seconds on the Praxis), fast return (timing as carriage return) and tab. The alternative is to use hardware consisting of something like a 555 timer with a variable current source depending on the character being printed, with the output from the timer being the busy line and used for character separation. To achieve a maximum transmission rate it would be necessary to find an internal (to the printer processor system) status line that will show if the printer can accept a character and then use this line for the BUSY/ACKnowledge reply to the computer.

When the computer outputs data on a Centronics interface the strobe line is made low for a short time (a few microseconds) to tell the printer that data is available.

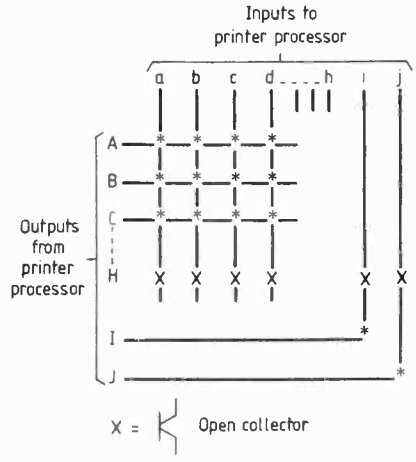

Fig. 1. Schematic of the matrix switching layout of typewriter keyboard. A keyswitch is present, normally open at intersections marked. Pull-up resistors to V_{cc} are connected to lines a to j inclusive.*

The printer responds by asserting BUSY and should pulse ACKnowledge low to signify that the character was accepted. When the printer is ready to accept another character it will drop BUSY. Many computer systems are content to ignore either BUSY or ACKnowledge but printers requiring line buffering (normally line printers) may use ACKnowledge to fill the line buffer and then assert BUSY whilst the characters are printing. Strictly the computer is not permitted to change the data on the Centronics port between the assertion of STROBE and the receipt

Charles Fortescue-Webb has been designing and producing microcomputer systems and electronic interfaces for eight years, with experience as chief engineer for a turnkey systems house in Ireland and as an independent consultant in microcomputer applications. His primary degree is in experimental physics and was followed by applied biomedical research for a M.Sc. degree. Application of minicomputers to the analysis and costing of civil engineering structures led onto work with microprocessor systems. His hobbies include sailing, bridge, woodworking and tinkering with cars and electronics.

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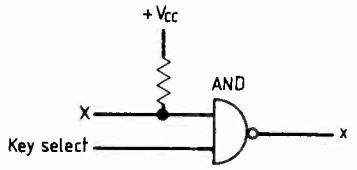

*Fig. 2. Possible connection method to simulate a key switch connection when key–select is high. This circuit would be substituted at each * in Fig. 1, in which case a low on X will be coupled through to x via the open collector gate.*

of an ACKnowledge, nor to assert STROBE whilst the printer is BUSY.

Circuit details

The functioning of the actual circuit is straightforward and the full schematic is shown in Fig. 4. The layout corresponds to that used in Fig. 3. The monostable between the strobe and busy lines is used to separate a multiple sequence of the same character into separate 'key depressions' by enabling the LS138 for a set time after each strobe pulse. The period of the monstable must be adjusted to be sufficient for the printer to recognise the character yet less than the intercharacter delay and the shown values provide a good starting point. The maximum R value is about 5kΩ due to limitations of the LS t.t.l. inputs.

The original was constructed on Vero d.i.p. breadboard using ribbon cable to couple the inputs and outputs. If a small system is being used then it may be more convenient to add on a eight-bit latch to the computer address/data lines rather that construct or purchase a specific parallel port.

If the keyboard uses greater than five volts then a small 5V supply will be needed for the logic and the inputs to the LS151 should be isolated using diodes connected in series with the lines to the LS151 from the keyboard with the anode connected to the interface. If a key is pressed on the keyboard whilst the interface is connected then the keyboard supply voltage can be coupled through to the multiplexer unless isolation from higher voltages is implemented.

The typewriter/printer lines are shown with the connection schematic for the Praxis. It is possible that your warranty on the typewriter could be effected by connecting this modification and so it is perhaps wise to wait until it is out of the warranty period. When making connections to this main board be aware that mos chips may be used internally and so static should be avoided (no nylon carpets, plastics worktops etc.). A soldering iron with low leakage or securely grounded would be a wise precaution if using soldered connections. If using a mains-powered wire-wrap tool then do not work on the interface whilst it is connected to the keyboard.

Detective work

One of the first operations is to examine the keyboard connections of the selected machine to ensure that it is possible to

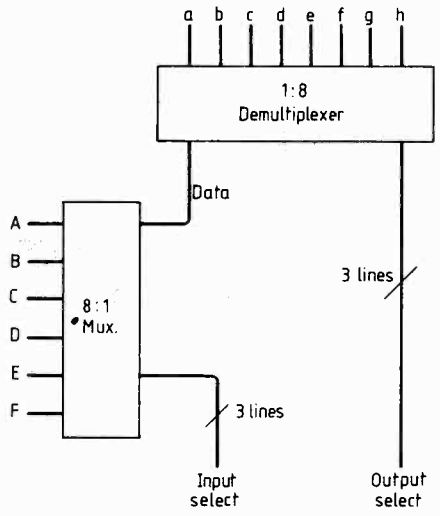

Fig. 3. Using a multiplexer and demultiplexer to replace a keyboard.

make the connections without having to, for instance, replace the complete case. First be quite sure that the mains cable is removed from the machine – a surprise jolt when you are probing inside the machine can do much damage to man and machine. On the Praxis after unscrewing the two platen knobs, without losing the small disc in the left hand one, four screws in the underneath of the case can be removed. Turning the case right side up again should enable the top section to be lifted off over the back of the machine. Be careful of the paper-holding bar. The keyboard can now be removed by undoing the two screws, one at either end, that hold the metal backing plate to the base of the typewriter case.

Lifting it off gently brings to light a number of connectors and these can be parted without putting any tension on the wires. At this stage the printer processor and electronics will be exposed to view along with three brass nuts positioned on the processor board that hold grounding straps and the processor board to the keyboard sub assembly. After noting the way in which the grounding straps are positioned the nuts can be undone and the keyboard and processor unfolded to show the printed circuit traces of the keyboard and processor connections. A drawing of the two boards opened out is shown at Fig. 5 with the connection points numbered to correspond with the schematic diagram Fig. 4.

Suppose that the typewriter is a different model from that used above. Then some investigation is necessary to find the connecting lines. Without the manufacturers service manual the best method is to follow the printed circuit traces to the various keys. Keyboard switches may have either three connections (with the outer two commoned-check with a meter) or just two. The key connection traces should either end up on a chip with open collector drivers (in which case they are being driven from the printer processor) or else be connected to pull-up resistors if an input to the processor. If the keyboard processor combination can be 'powered up' whilst access is retained to the keyboard traces then processor output wire should have no or small voltages on them whilst processor input traces should be at 5V due to the pull-up resistors. In any event, provided that the keyboard is powered from five volts, an incorrect connection of the traces

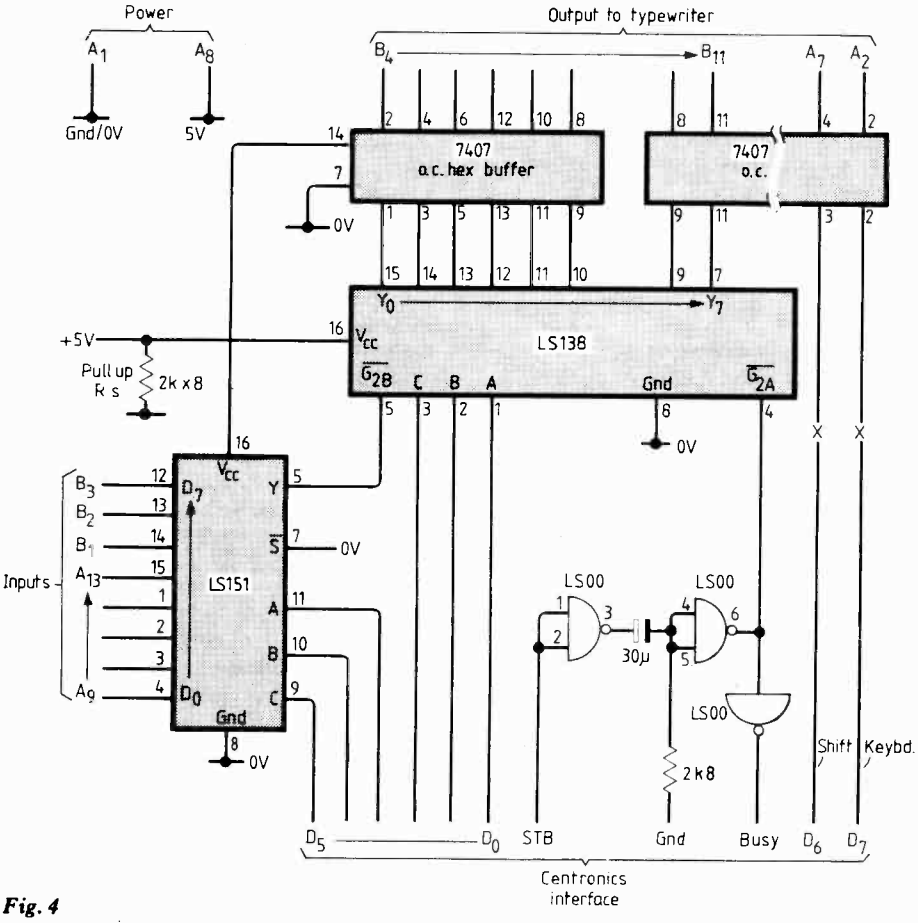

Fig. 4

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to the interface will not cause damage but prevent the interface and/or the typewriter working properly. There is no need to assign specific assignments to each of the input/output connections on the interface since a software routine is used later to determine the actual data required to simulate a specific key closure.

The next stage is to determine the output data required for each simulated key closure. Connect up the computer-interface-typewriter combination and then run a program to output characters (with data values in the range of 0 to 255) and see what the response is from the typewriter. Be aware that some of the unused code can cause the typewriter to 'lock out' and not accept any more input. If this should happen the easiest way to recover is to turn the typewriter off then on again to reset the internal mechanism. Also some software driving parallel output ports will only output seven bits, the most significant bit being masked off as it is not used by many printers. If this is the case with your system then either the driving software can be altered or alternatively one of the dedicated lines (I . . . i, J . . . j in Fig. 1) can be deleted.

In the case of the Praxis this would mean that keyboard 2 was not available but for many applications this would be quite acceptable. The program in Fig. 6 which is written in Pascal will provide you with a file of the data and corresponding characters printed. If you find that the interface is behaving badly, for instance by not printing all characters then check both the interface and connections to the keyboard traces. It is easy to have 95% functionality even though the shift line say is not connected.

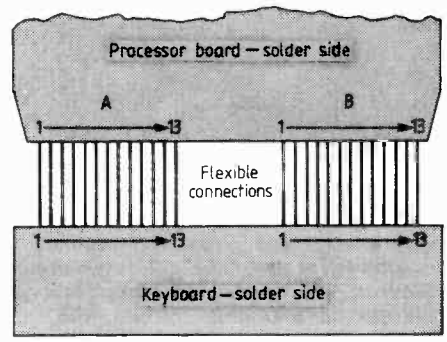

Fig. 5. Connection points on the opened out Praxis processor and keyboard.

List 1. Program to produce a file 'Trans. text' of ascii character and corresponding code to operate printer.

```
Program Decode; (* Pascal under UCSD Version 4 *)

var  Translation_file  : text; (* data and character file *)
     Printer           : text; (* Treated as a file *)
     j                 : integer; (* loop variable *)
     ch                : char ;  (* character read from vdu *)
Begin;      (* program from hereon *)
Rewrite( Translation_file,'Trans.text'); (*Open Output file *)
Rewrite( Printer,'Printer:');            (*Open  Printer*)

For j := 0 to 255 do begin;   (* main loop *)
  Write(printer,chr(j));      (* data to printer *)
  Write(' Enter character printed ( ^ for non printing)');
  Read(ch);                   (* read character inputted from vdu *)
  writeln;                    (* new line on vdu*)
  writeln(Translation_file,j:5,ord(ch):5);  (* write to file *)
  end;                                      (* end of main j loop *)

Close(Translation_file,Lock);  (* keep the translation file *)
end.
```

List 2. Program to show how translation data can be used to run typewriter using codes from program in List 1.

```
  Program Encode;  (* Uses translation file to print on typewriter *)
  Const  cr = 13;  (* carriage return ascii value *)
  Var  Printer   : text;
       Decode    : Array(0..255) of 0..255;  (* holds printer codes *)
       k         : char; (* only used in demonstration program *)

  Procedure PRINT_INIT;  (* Initialises for the Printer *)

  Var  Translation_file  : text; (* data setup in program DECODE *)
       data, code, j     : integer;

    Begin;  (* procedure Print_init *)
    Reset ( Translation_file, 'trans.text'); (* Open file *)
    For j := 0 to 255 do Decode(j) := 0; (* initialise Decode array *)
    For j := 0 to 255 do begin;          (* file data to decode *)
       Read   (translation_file, data, code  ); (* read a line from file *)
       Decode(code) := Data;             (* and put to decode *)
    End;                                (* of the j loop *)
    Close(Translation_file);            (* no further need for this *)
    Rewrite(Printer,'printer:');        (* open printer for output *)
    end;                               (* of procedure Print_init *)

   procedure delay(ticks:integer); ( gives a 'ticks' milliseconds delay )
   var i,j,k:integer;
   begin;
     For i := 1 to ticks do
        For j := 1 to  8  do k := k+1;( 1 ms delay )
   end;

Procedure PRINT ( ch: Char );  (* accepts a character for printing *)

Var    i  : integer;

  Begin;       (* Procedure PRINT *)
  i := ord(ch);     (* find integer value of ascii character *)
  i := decode(i);  (* and use to get printer data *)
  write(Printer,chr(i)); (* and output to Printer *)
  if ch = chr(cr) then delay(1000) else delay(90); (*  11 c/sec *)
  end;
End; (* of Procedure Print *)

Procedure PRINT_EXIT; (* called after finished with printer *)

  Begin;                    (* start of Print_exit *)
  print(chr(cr));           (* Carriage return to Printer *)
  Write(Printer,chr(255));  (* Holds interface out of action to
                               enable all typewriter functions *)
  Close(Printer);           (* No further use for printer *)
  End;             (* of Procedure Print_Exit *)

BEGIN;

  (* This is where your main routine would be.  The following
    is a short sample Program that can be used to test the
    interface, and would not be present for normal use *)

    Print_init;   (* initalise the printer channel *)

    For k :='A' to 'z' do begin;
      write( k );  (* put out the character on vdu *)
      print (k);   (* and on the printer to check correct action *)
    end;

    Print_Exit;  (* and close up the channels *)
END.
```

Operation

The final step is to generate a small program that takes any character that you wish to output to the printer, translates this to the appropriate data code, and then outputs it on the parallel interface. The best method of implementing such a routine is in assembly language and then to incorporate it into the bios (basic input-output system) so that the operation is transparent to the host program. To give an idea of what is required and to provide a basis for further experimentation the small routine shown in Fig. 7 is written in Pascal and can be incorporated into an applications routine. The routine is broken up into three procedures: Print-init to open the printer channel, Print to actually translate and output the characters and Print-over to perform any closing tasks. Note that the main translation array TRANS must be declared in the main routine since Pascal cannot hold local variables from call to call of a sub routine. If you wish to use the printer for word processing then you will probably want to extend this program to enable such things as underlining and printing both £,p and $,c.

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Improving colour television decoding

4 – Simple one-line comb decoder on a small single board can be added to existing receivers

by D. C. A. Read
B.Sc. (Eng), M.I.E.E.

Much of the background material and illustrations in these articles derives from the author's BBC work and that of his colleagues in the Research and Designs Departments. The particular proposal for a domestic receiver decoder described here is the author's own rather than a BBC concept.

Considering now the actual electronics, Fig. 34 shows a circuit diagram of the video path built to incorporate the foregoing principles (part 2, January issue). Composite video (1V pk-pk) is applied to the circuit to produce outputs that are suitable for the various decoder chips now readily available. Output pins can directly feed the decoder chips TDA3516A or 3560 from Mullard.

Transistors Tr_1 and Tr_2 are complementary emitter followers providing low-impedance drives, appropriate resistors being fitted to match the delay-line characteristic impedance and the chroma bandpass filter impedance. Also, a low-impedance feed is available for the sync filter which is an optional extra. The three coils and capacitors (L_{1-3}, C_{5-7}) form a symmetrical gaussian bandpass filter (described later) set up by adjusting all three inductors so that maximum subcarrier level occurs at the output, also with minimum 7.8kHz at chroma transitions.

The filtered chroma signal is fed out via Tr_{18} to provide low-impedance drive to the chroma input pin of the demodulator chip or chips. PAL decoding i.cs normally use a chroma-length line (64μs−56ns) to provide delay-line PAL decoding for enhanced U/V separation in the chroma circuits. Colour prints 7, 8 and 9 are screen photographs with luminance off, showing, in print 7, the chroma demodulation performance using the field sweep skew test waveform for line-by-line decoding. Print 8 shows one chroma line in use i.e. combing the chroma over two lines; this is the standard method in most television sets. Using two-line delays, print 9 shows three-line combing in the ratio ¼:½:¼. The third line has no offset whereas the centre line has a 56ns offset. No further chroma work was felt necessary on this add-on card and this design will use one chroma line. This is a reasonable compromise which provides some comb filtering of the luminance, a 3-dB reduction of fine cross-colour, and, by adding and subtracting equal amplitude from the two lines, a 3dB reduction of random noise occurs. The slight loss of vertical resolution is only apparent when viewing computer graphics. Spatially, on horizontal transitions, the luminance and chroma are displaced by half a line in the field, but this is only seen on electronically generated signals.

In the circuit of Fig. 34, Tr_3 amplifies the signal from the chroma bandpass filter to provide a high level input for the DL60 delay line, which has a typical insertion loss of 11dB. The output transducer of this delay line is floating and can therefore provide a balanced push-pull drive to the MC1596 balanced modulator input with the d.c. supply bias provided by resistors

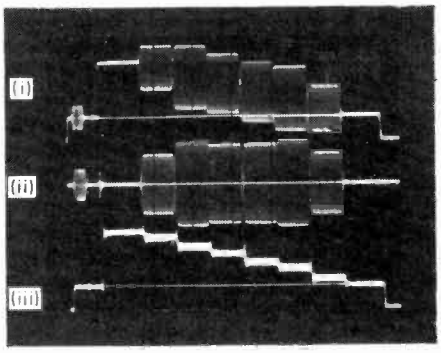

Fig. 35. *Modifier comb-circuit waveforms. Top trace is the input composite PAL video signal, middle trace shows the chroma envelope after the Tr_1, Tr_2 buffer and gaussian bandpass filter. After a further buffer this signal is fed out to pin 3 of the decoder TDA 3561A (or 3560) (if the one-chip decoder is used). Minimum 7.8kHz twitter at chroma transition indicates good group delay symmetry in the gaussian filter. Bottom trace is the luminance signal as fed to pin 10 of the one chip decoder.*

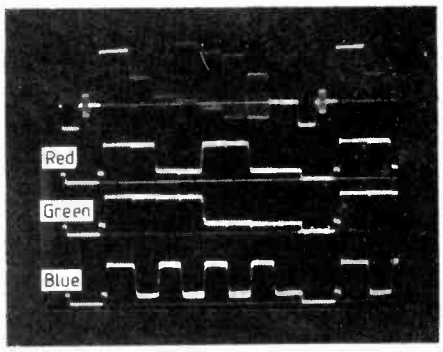

Fig. 37. *Signal waveforms for the complete decoder. Top trace is 1V composite video input. The lower three traces are red, green and blue outputs from the modifier comb and TDA3516A (or TDA 3560) chroma chip.*

The full extent of picture improvement can only be achieved if the suggested modifications are incorporated into a receiver in which attention has been paid to a number of other aspects of performance, a similar experience to improving high quality audio. These would include the use of a 26in tube (preferably high resolution), an efficient aerial (possibly with a down-lead amplifier), a tuner and i.f. amplifier response flat to 5.5MHz and with the demodulated video group-delay equalized to give minimum phase errors. It would also be beneficial to receive the incoming r.f. signal from a transmitter of good performance.

The performance of the modifier used to comb chroma from the composite signal (to provide clean luminance) is degraded in the presence of phase errors. These errors are largely introduced by the video signal modulation and demodulation processes and mainly comprise poor group delay response across the chroma bandwidth ($f_{sc}\pm1.3$MHz) and by differential phase (chroma phase shift with the change of luminance level).

Further information on transmitter performance and alternative circuits to place between the i.f. output and the PAL decoder will be given in a later article. These alternative circuits would be preferable for smaller screen sizes (assuming the standard tv receiver tube).

Some other developments which will be of relevance if the time delay for their introduction and cost are not too great are ITT's digital tv i.cs and the Philips n-mos memory chips. Philips also make a high resolution 26in tube (which will probably double the standard tube price) that can be operated at twice the normal line and field scanning rate. Memory chips store the incoming signal over a field or picture period; video information is thus available for scanning twice in the period of one input picture. This double scanning removes flicker and enables other decoding methods to be used, as outlined in the December and January articles. (See also the German Radio Show report, November 1983 issue pages 74, 75.)

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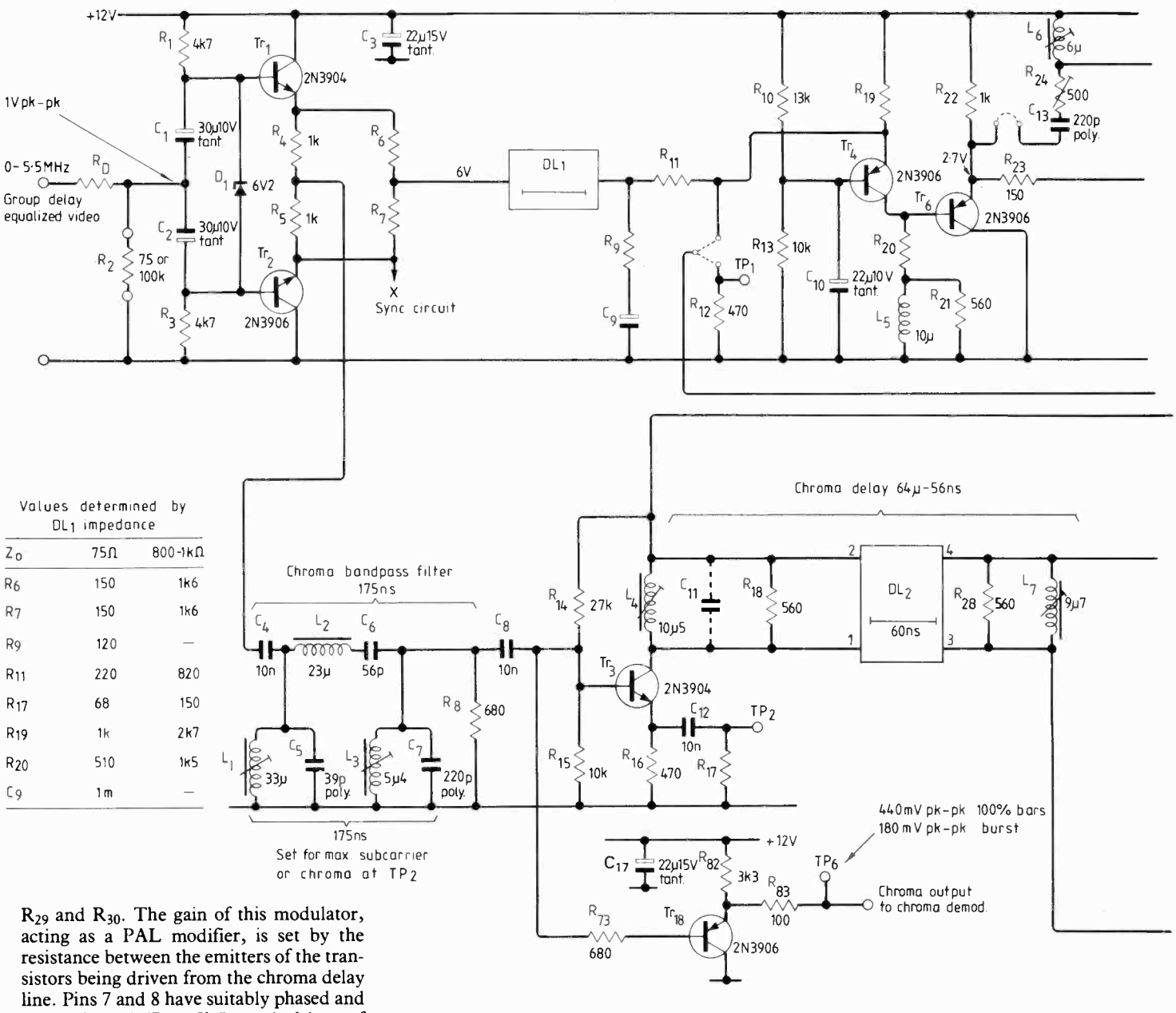

Values determined by DL1 impedance		
Z_0	75Ω	800-1kΩ
R_6	150	1k6
R_7	150	1k6
R_9	120	—
R_{11}	220	820
R_{17}	68	150
R_{19}	1k	2k7
R_{20}	510	1k5
C_9	1m	—

R_{29} and R_{30}. The gain of this modulator, acting as a PAL modifier, is set by the resistance between the emitters of the transistors being driven from the chroma delay line. Pins 7 and 8 have suitably phased and d.c. balanced (R_{42}, 5kΩ pot.) drives of 8.8MHz (twice colour subcarrier) taken from the chroma demodulator chips via buffer stages Tr_8, Tr_9 which also provides phase shift. The two phase shifters plus the changeover shown adjacent to C_{28} and C_{29} mean that the change in phase setting available to the modulator is in excess of 360°. Thus a setting will always be found, regardless of the decoder chips being used, to obtain the correct phase in the overall system. Pin 9, the demodulator output is fed directly to a grounded base stage via 10nF blocking capacitor (C_{21}). Therefore no signal can be seen at pin 9. Also summed at the grounded base stage is the composite PAL video from the luminance delay line. The delay of this, compared with the delay time through the gaussian bandpass filter plus the DL60 delay line and the modifier, is such that the two signals summing at the grounded-base stage are exactly 64µs apart.

The collector load of Tr_4, R_{20}, gives sufficient gain to provide a suitable level to the output filter, this being buffered by emitter follower Tr_6 and R_{23} (150Ω) representing the characteristic impedance to the output filter.

The first sections L_8 and L_9, form a phase/group delay equalizer as is L_{10}. The filter itself is formed by L_{11} and L_{12}; the last element in the filter L_{12} has an additional capacitor switched in by the f.e.t. to bring it to resonance at subcarrier frequency when the notch is needed, such as at a horizontal colour transition. As the notch switches in and L_{12} becomes resonant, the input impedance to the filter rises. The small resulting increase in voltage available at Tr_6 emitter therefore drives Tr_5 harder and the notch 'snaps in' with a positive-feedback effect. Components L_6 and C_{13}, with variable resistor R_{24} are in series resonance at subcarrier frequency; R_{24} is adjusted to set the threshold of the notch. The notch will switch in very quickly with Tr_5 bottoming on the peaks of the 4.43MHz oscillations developed across L_6. With R_{25} of 10MΩ the decay is slow, switching the f.e.t. off about half a line later.

If the voltage supplied to the gate of this f.e.t. is displayed on a black and white receiver with an external sync feed and viewed adjacent to the colour receiver, the amount of time the notch is in is shown to represent a very small proportion of the total picture area. The loss of resolution can therefore be considered slight. It is also statistically unlikely that fine luminance detail will occur on horizontal colour transitions when the notch is switched in.

If luminance detail is continually present at 4.43MHz, the notch will be introduced and detail lost; it is as if the notch were always present. But the delay in operation of the adaptive notch switch will allow luminance edges through unscathed and this gives subjective improvement to the picture resolution.

It has been found in practice that with an input of test card F from a slide scanner, the threshold control resistor is best set so that the 4.5MHz gratings pass through with minimal degradation. Subcarrier from horizontal coloured edges will then cause the notch to switch in if the amplitude increases above the equivalent amplitude of this 4.5MHz grating. The 4.5MHz grating on the analogue test card (about to be replaced by a digital one) is well below the 0.7V black-to-white amplitude. However, switching to the electronically generated signal Channel 4 test card, the notch is permanently in during the 4.5MHz grating. But on pictures, the notch switches in when horizontal dot

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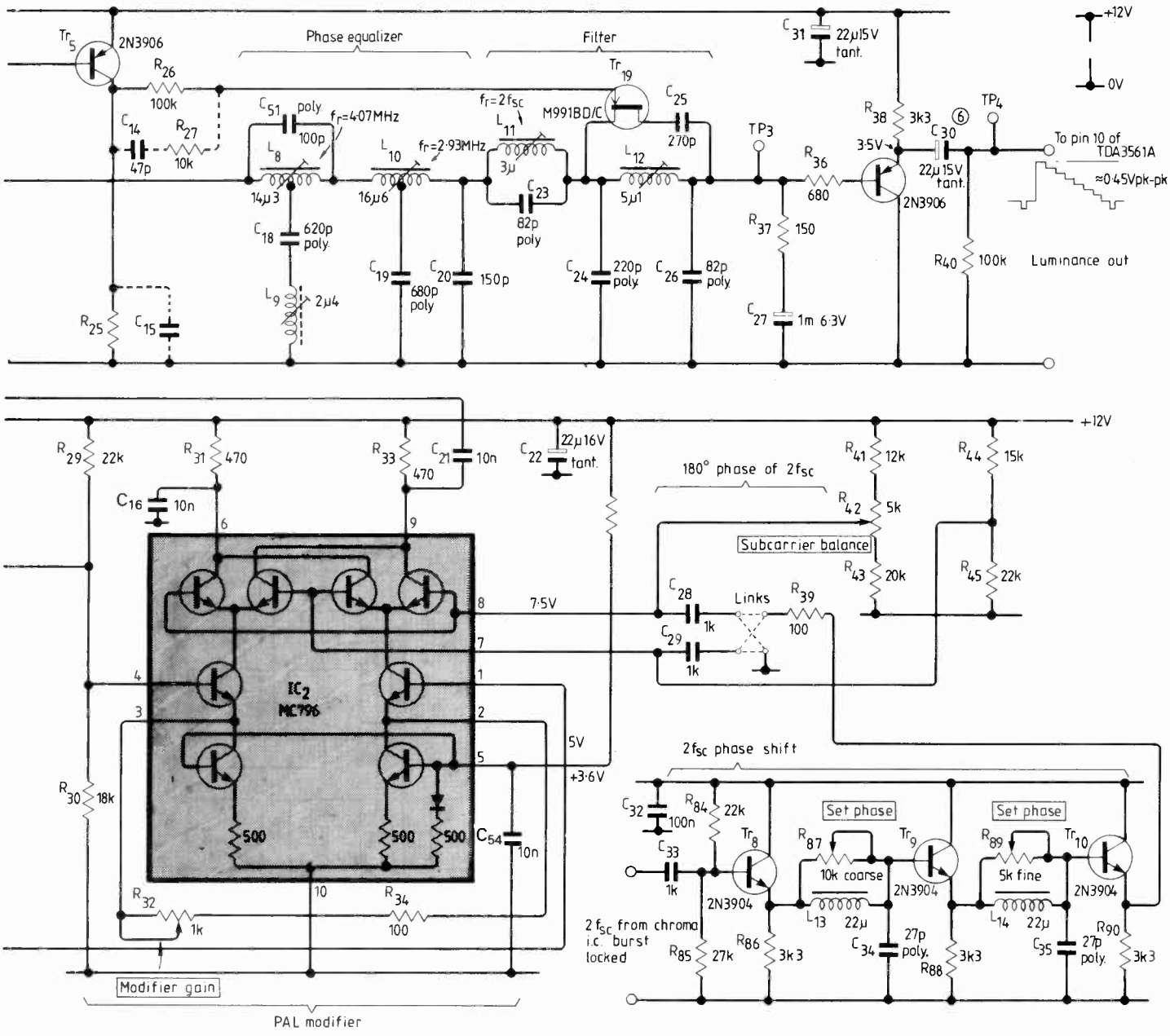

Notes

① L_5 and R_{21} can provide 1 to 3dB h.f. lift, normally shorted by link.

② R_{25} 10MΩ for slow turn-off of adaptive notch, 100kΩ for fast turn-off

③ C_{14}, R_{27} slightly speed-up switch-on but need not be fitted. Set for best 2T lobes

④ C_{11} not fitted but can be used to trim phase

⑤ Poly ≡ 2% polystyrene Cer ≡ ceramic disc or Redcap/Bluecap

⑥ C_{30} 100µ 12V Mullard for three-chip decoder. Lum. input has 2k7 in series & 22k to 12V. Remove R_{40}

⑦ Refer to next installment for filter adjustments

⑧ Inductors are wound with 5 or 6-strand 48 s.w.g. Litz or 38 s.w.g. (0·16 or 0·14mm dia.) enamelled copper wire

***Fig. 34.** Diagram of circuit that processes chroma and luminance signals.*

Inductor details

No.	Value (µH)	Turns Neosid E2	Turns Toko 10K
1	33	37	55
2	23	34	42
3	5·4	15	18
4	10·5	21	27
5	5	Painton or Sigma choke	
6	6	16	21
7	9·7 or 10	20·5 Painton or Sigma choke	26
8	14·3	13+13	16 16
9	2·4	10	13
10	16·6	14+14	17+17
11	3·8	13·5	16
12	5·1	15	18
15	150	Painton or Sigma choke	

crawl becomes just visible at normal viewing distance, assuming ≤3.5×screen diameter. This seems a suitable criterion for determining the threshold of the notch. It may be considered that a slightly lower threshold which degrades 4.5MHz gratings on the test card will further reduce visibility of horizontal dot crawl. This is a setting which will be made subjectively to suit the individual.

At the output of the filter the signal is terminated (R_{37}, 150Ω) and buffered. Transistor Tr_7 provides a low-impedance drive output as many clamps in decoder chips require a low-impedance point. The coupling capacitor may have to be changed to suit the time constant of such clamps, depending on whether the extra circuit board is fitted to a three, two or one-chip decoder.

Setting-up procedure (luminance)

In the first place, it is required to obtain a timing difference between the two signals summed at Tr_4 emitter of exactly 64µs. 100% colour bars are used as the test signal, although 95%, 75% or EBU bars would be suitable.

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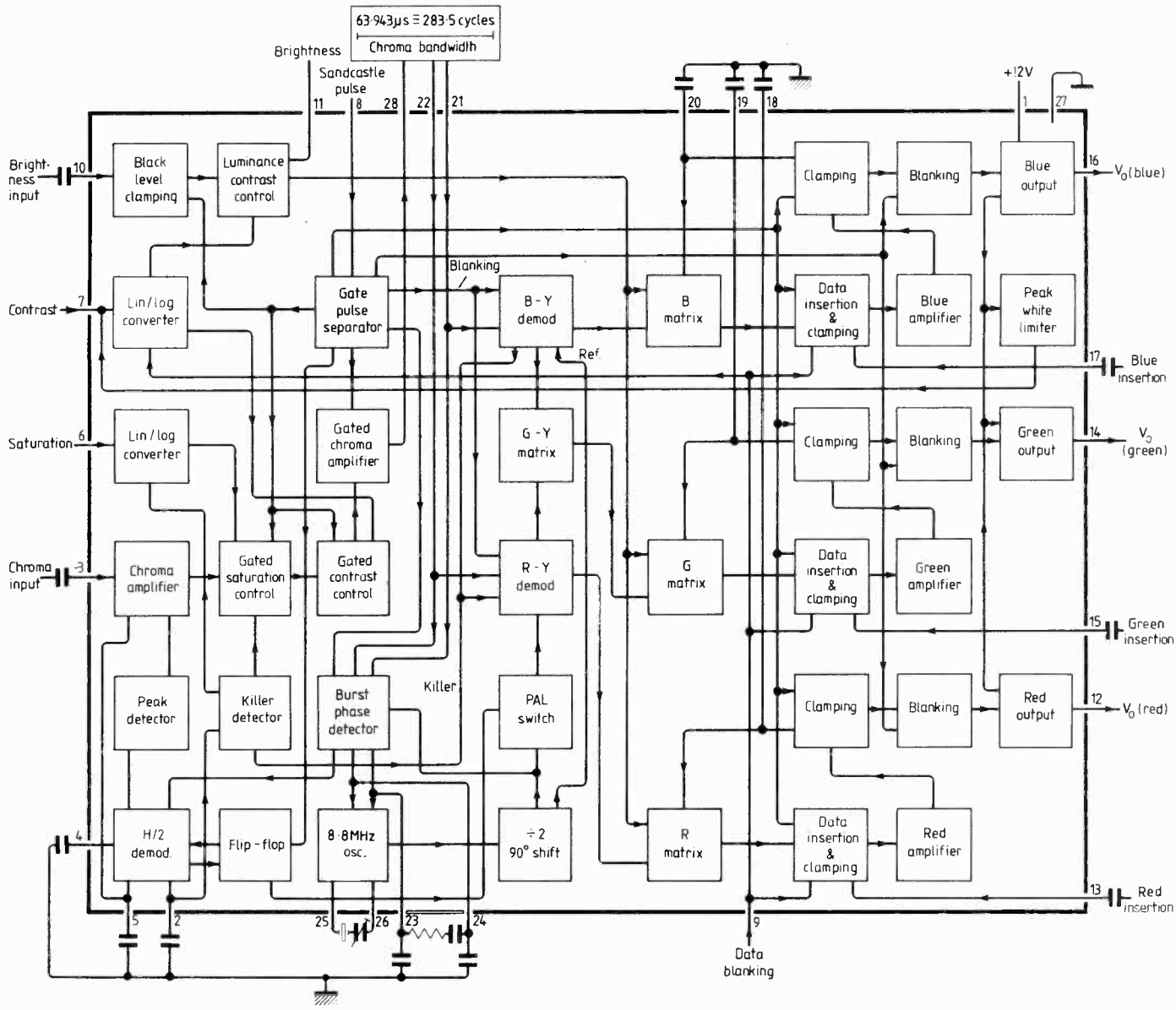

1. Disconnect either the input or output end of DL_1, and with the $2f_{sc}$ feed also disconnected (by removing the links adjacent to C_{28} and C_{29}) unbalance the modifier pins 7 and 8 (R_{42} turned to an end-stop).
2. With the output of the modifier linked to R_{12}, TP_1, the chrominance passing through the gaussian filter and DL60 delay line can be displayed on an oscilloscope and the signal path checked.
3. Reconnect the modifier Tr_4 emitter so that the chroma envelope can be seen at the output test point TP_4 (Fig. 34). The waveform appearance should be as shown in Fig. 35, middle trace. The green/magenta centre transition, will need to be expanded on the oscilloscope so that the signal is resolved down to 50ns (see Fig. 24, January).
4. The link at TP_1 is switched so that the modifier output is across R_{12} and is not fed into Tr_4 emitter. Reconnect $2f_{sc}$, put the oscilloscope probe on TP_1 and rebalance pins 7 and 8 on the modifier so that the carrier ($2f_{sc}$) is nulled to zero. This represents carrier balance of the modulator/modifier.
5. Again feed the direct composite PAL signal to Tr_4 emitter by reconnecting DL_1. This results in the colour bar signal being seen at the output test point TP_4 (Fig. 35 top trace); the delay line must now be adjusted so that the green/magenta transition occurs exactly at the same timing as it would in the gaussian/DL60/modifier route. The aim should be to get a timing coincidence of better than 50ns and as good as 20ns if possible (top trace, Fig. 24 January). Note the amplitude.
6. Disconnect either the input or output lead of DL_1 as before, re-connect the modifier (link at Tr_4 emitter), adjust the gain of the modifier with R_{32} (1kΩ pot.) to obtain the same chrominance amplitude as in preceding step.
7. Reconnect the luminance (link at DL_1), with the chrominance from the modifier also being summed at Tr_4 emitter, it only remains to adjust the phase of the modifier output. Using R_{86} (10k pot.) and R_{89} (5k pot.), the coarse and fine phase adjustments in the $2f_{sc}$ feed (and, possibly, the links adjacent to C_{28} and C_{29} for 180° change), a point will be reached where the phase of the chroma from the modifier will cancel the chroma of the composite PAL signal.
8. The amplitude of the $2f_{sc}$ feed from the phase shifting stages $Tr_{8,9,10}$ can be from 0.3 to 1.3V pk-pk and it may be necessary to adjust C_{34} and/or C_{35} to obtain reasonably constant amplitude as the appropriate 'set phase' controls are taken between end stops. Check at Tr_9 emitter first and adjust C_{34} on test for constant amplitude over the full range of R_{86}. Repeat for C_{35} and R_{89}.
9. Finally to achieve the best null and to optimise the chroma cancellation on all levels (steps) of the resulting luminance, a small adjustment on the gain will be required. It is as well to use the gain pot (R_{32} 1k) the phase pot (R_{89} 5k) with the modifier balance pot (R_{42} 10k) in a converging sequence to minimize residual subcarrier for all the steps in the luminance signal.

The normal functions expected of a PAL decoder are adequately provided by the Mullard one-chip decoder TDA3561A. The chip requires separate chroma and luminance inputs – the circuit of Fig. 34 provides these in enhanced form. Pin 25 feeds PAL modifier via Tr_{15} in Fig. 34.

The trace in Fig. 35 shows the composite PAL signal as measured across R_2 (input

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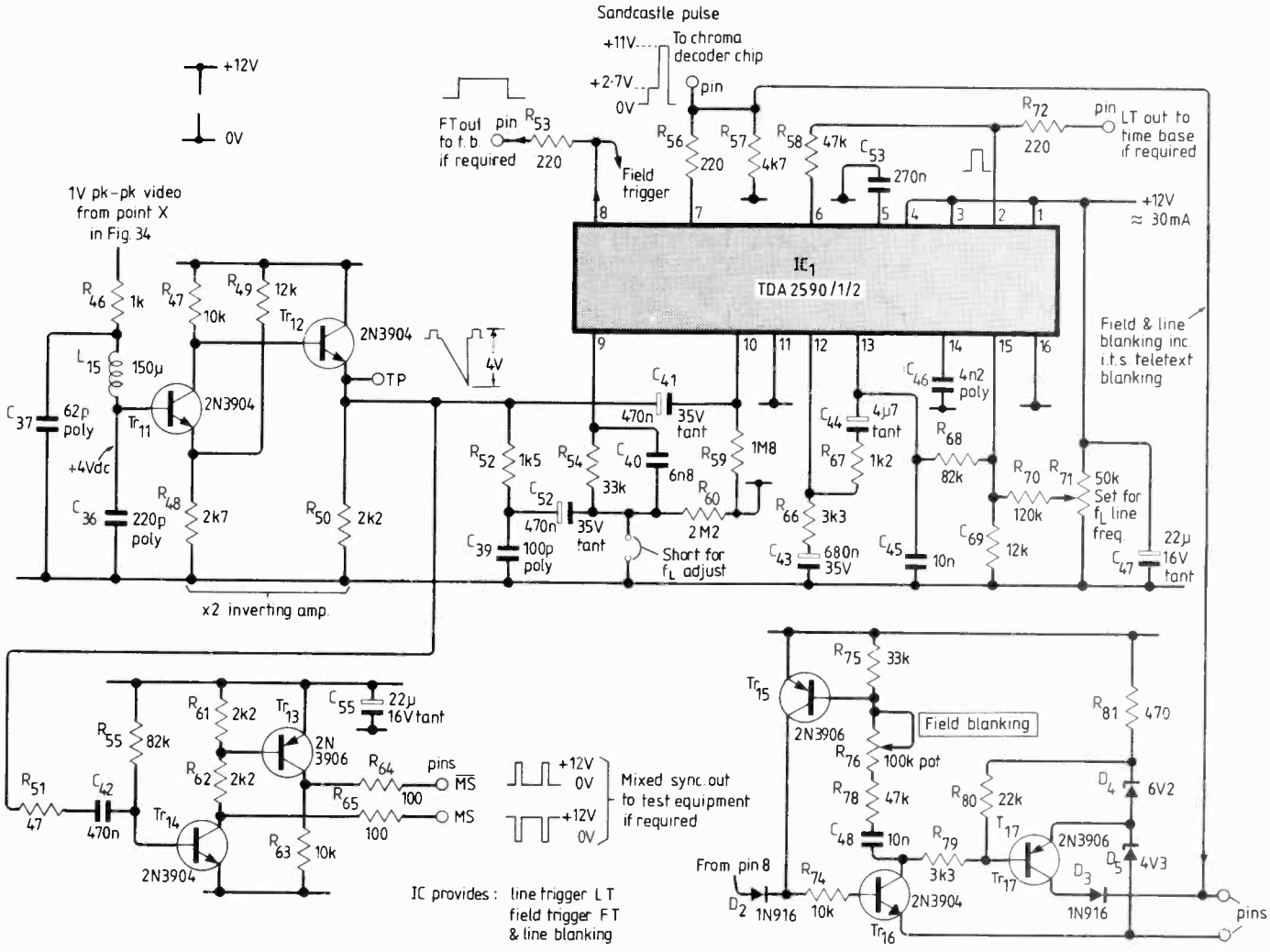

***Fig. 36.** Diagram of circuit of sync processor chip providing field blanking and other pulses.*

terminating resistor), the middle trace is the chrominance at TP_2 which is being fed out to the chroma circuits of the demodulator (external to this additional circuitry), and the lower trace at TP_4 shows that the chroma from the modifier output is cancelling the composite PAL chroma to leave a clean luminance signal.

Fig. 36 shows some optional additional circuitry that may be used depending on the receiver to be modified. Point X is taken from the emitter of the input buffering pair in Fig. 34, Tr_2. This feeds a filter with a characteristic impedance of 1kΩ provided by R_{46}. The high-impedance terminated filter has a low-pass linear amplitude response which removes all the subcarrier and highband luminance energy but retains the sync risetimes with optimum shape. The filter design will be detailed later with group delay/phase and amplitude responses. Transistor Tr_{11} amplifies the signal and Tr_{12} emitter follower drives the sync separator chip IC_1, (TDA2590). There are other versions i.e. 2591, 2592, 2593 but in this application the available alternatives are not important. All the chips are capable of driving line output stages and field scan i.cs directly.

The chip has a sync-slicing system which is self-adjusting, according to the video amplitude, to maintain a 50% slice on sync edges. The line frequency can be set to approximately 15.625kHz using R_{71} (50kΩ pot) with the input signal shorted at the points shown adjacent to C_{52}, R_{60}.

When the short is removed, the phase locked loop is centralized. This chip also provides field triggers and line triggers. By feeding the line trigger output pulse back into the chip (on pin 6 via R_{58}) a 'sandcastle' pulse is generated which, if necessary, is then available for the chroma decoder chip. In most of the receivers, however a sandcastle pulse is already available and this circuitry would not be required.

The line and field trigger pulse trains could both be used to drive line and frame time bases if the whole receiver is being engineered. There is another optional circuit available. This widens field trigger pulses via the monostable (Tr_{15}/Tr_{16}) and thus provides blanking of the ITS (insertion test signal), and teletext (Ceefax and Oracle) and other data signals in the field block. See Fig. 38.

On the author's attic workroom receiver, the picture is underscanned so that all four corners can be seen and the 'business' at the top of the picture becomes unacceptable without widened blanking The extra blanking circuit ensures that only active picture lines are displayed. The other optional extra, formed by Tr_{13} and Tr_{14}, is solely used to drive test gear which needs to be locked to mixed syncs.

The luminance output of the board from Tr_7 can be coupled into the Mullard one-

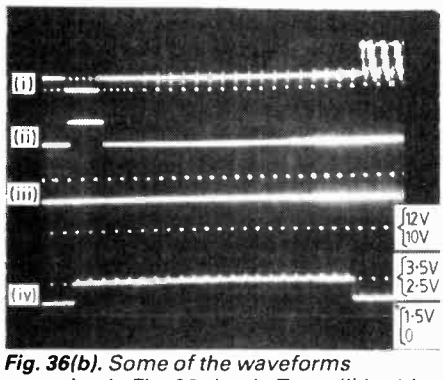

***Fig. 36(b).** Some of the waveforms occurring in Fig. 36 circuit. Trace (i) is video signal fed to pre-sync separator filter C_{37},L_{15} and C_{36}. (ii) is field trigger from pin 8 of TDA2592 and (iii) line trigger from pin 2, (iv) shows RGB clamping (top), output picture blanked (middle) and active picture – line and field blanking off (bottom).*

chip TDA3561A (or 3560) which is mainly used as a colour decoder (see Fig. 20, January issue pages 54, 55). The coupling component feeding the luminance input, on pin 10 can be a 0.47µF non-polarized ceramic/polyester capacitor. The chrominance input on pin 3 fed from Tr_{18} also requires d.c. blocking; 10nF is suitable. The d.c. on both pins 3 and 10 of the decoder chip are typically 2.2V and the output on Tr_7 is typically 3.5V. If a small tantalum capacitor is used, check for polarization particularly where other chips are employed.

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Full amplitude levels in I.T.S. and the high levels of teletext plus I.C.E. signals (internal communications equipment) need to be fully blanked.

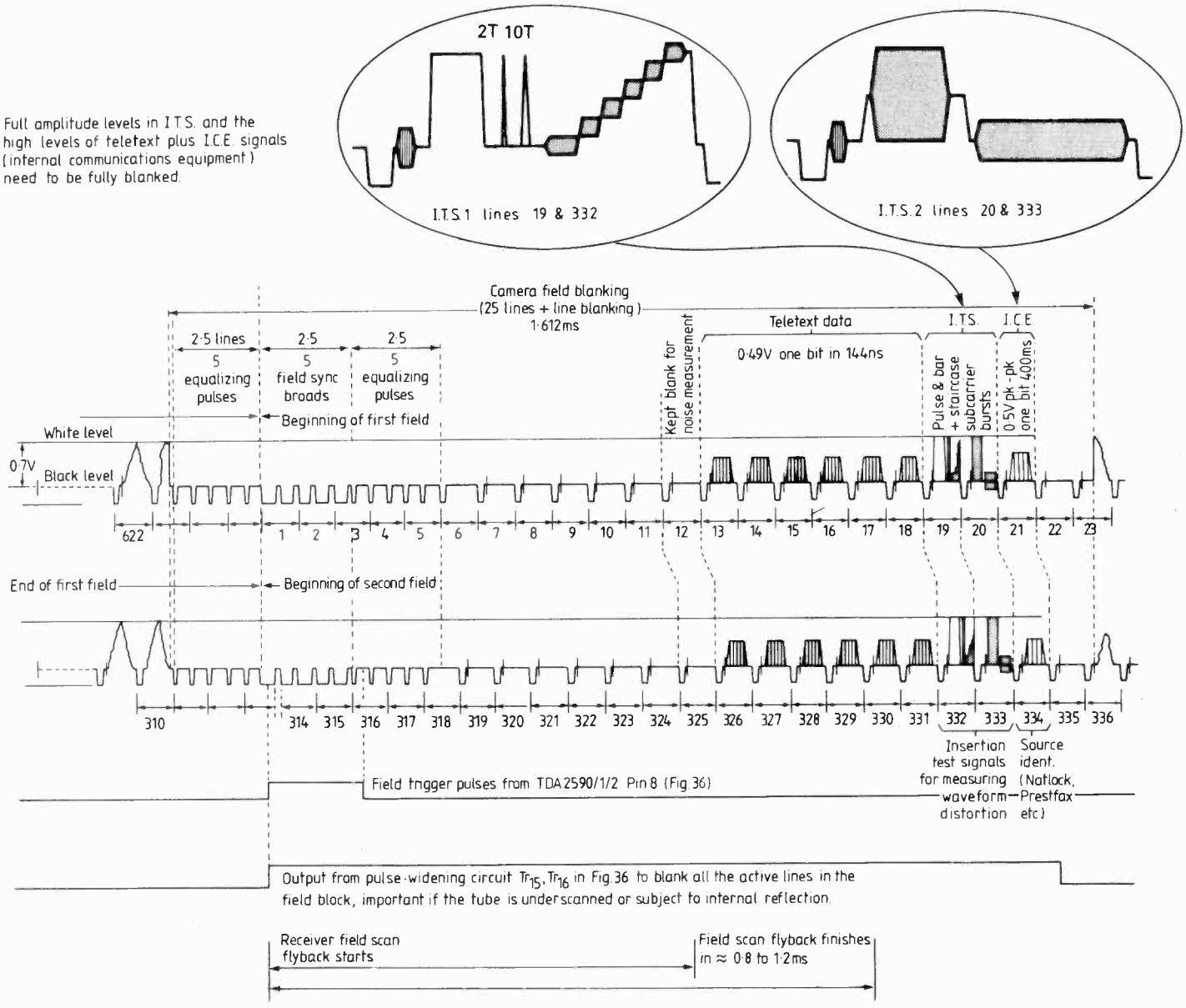
2T 10T
I.T.S.1 lines 19 & 332
I.T.S.2 lines 20 & 333
Camera field blanking (25 lines + line blanking) 1·612ms
2·5 lines
5 equalizing pulses
2·5
5 field sync broads
2·5
5 equalizing pulses
Beginning of first field
Kept blank for noise measurement
Teletext data
0·49V one bit in 144ns
I.T.S.
I.C.E.
Pulse & bar + staircase subcarrier bursts
0·5V pk-pk one bit 400ms
White level
0·7V
Black level
622 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23
End of first field
Beginning of second field
310 314 315 316 317 318 319 320 321 322 323 324 325 326 327 328 329 330 331 332 333 334 335 336
Insertion test signals for measuring waveform distortion
Source ident. (Natlock, Prestfax etc)
Field trigger pulses from TDA2590/1/2 Pin 8 (Fig 36)
Output from pulse-widening circuit Tr_{15}, Tr_{16} in Fig 36 to blank all the active lines in the field block, important if the tube is underscanned or subject to internal reflection
Receiver field scan flyback starts
Field scan flyback finishes in ≈ 0·8 to 1·2ms

***Fig. 38.** Vertical synchronizing and blanking waveforms. As shown, field blanking interval lines are also used for teletext, ICE (internal communications equipment), ITS (insertion test signals), and clear lines for noise measurement. TDA2562A also uses lines 21, 22, 23 for RGB tube black-level stabilizing.*

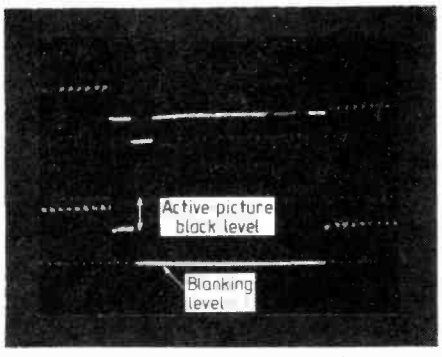

***Fig. 38(b).** Off-air video signal and extra blanking to prevent any adverse visibility at the picture top. Top trace shows some lines in use in the field blanking period. Bottom trace is final green drive to display tube, indicating line blanking and extra field blanking provided by the circuit of Fig. 36.*

Provision was at one time made to adjust the chroma level output with a pair of resistors attenuating the feed to Tr_{18} base. When adjusting the level feeding the decoder chip TDA3561A or the equivalent two and three-chip versions, it was found to be difficult to determine which chroma level suited the decoder to obtain maximum chroma linearity (the linearity being somewhat poor). Also the matrix which produces the red, green and blue signals from the luminance and colour-difference signals can have up to 10% and amplitude errors. By optimizing the chroma level and averaging out the matrix errors across the RGB outputs a fairly good compromise can be achieved as is shown in the photograph, Fig. 37.

The blanking as generated by the extra circuitry Tr_{16}, Tr_{17} and IC_1 (TDA 2590/1/2/3) is applied to the blanking input of the TDA3561A chroma demodulator chip. A line-rate trace of the blanking component is shown in Fig. 37 in which the fainter line represents the field blanking. Using this trace and with the oscilloscope timebase switched to field lock, the pot R_{76} is adjusted so that the field blanking ends at the beginning of the first line in the active picture. The blanking should end half way through line 23 in the first (even) field, and at the beginning of line 336 on the second (odd) field; see Fig. 38. The insertion test signal (two lines per field), teletext information (four lines per field or six lines on some channels), and the ICE signal (internal communications equipment coding line), will then all be blanked by the widened field pulse.

With the extra board (modifier etc.), set up, the picture will attain a horizontal resolution which is close to the vertical resolution. The equivalent vertical and horizontal resolutions can be calculated as follows. There are 625 lines transmitted in each picture period (40ms) but as 25 lines are blanked in each field (20ms) there are only 575 active lines in each picture or 287.5 active lines per field. These 287.5 lines determine the vertical resolution, i.e. the maximum number of cycles that can occur within the picture height. The transmitted pictures has a horizontal to vertical aspect ratio of 4:3, so 287.5 vertical cycles are equivalent to 383.3 horizontal cycles. Given that the active line period is 52μs (64μs less 12μs blanking), the period for each cycle of this maximum equivalent horizontal resolution then is 135.62ns (52/383.3). The frequency is to equivalent to 7.37MHz. This is the justification for improving the horizontal resolution.

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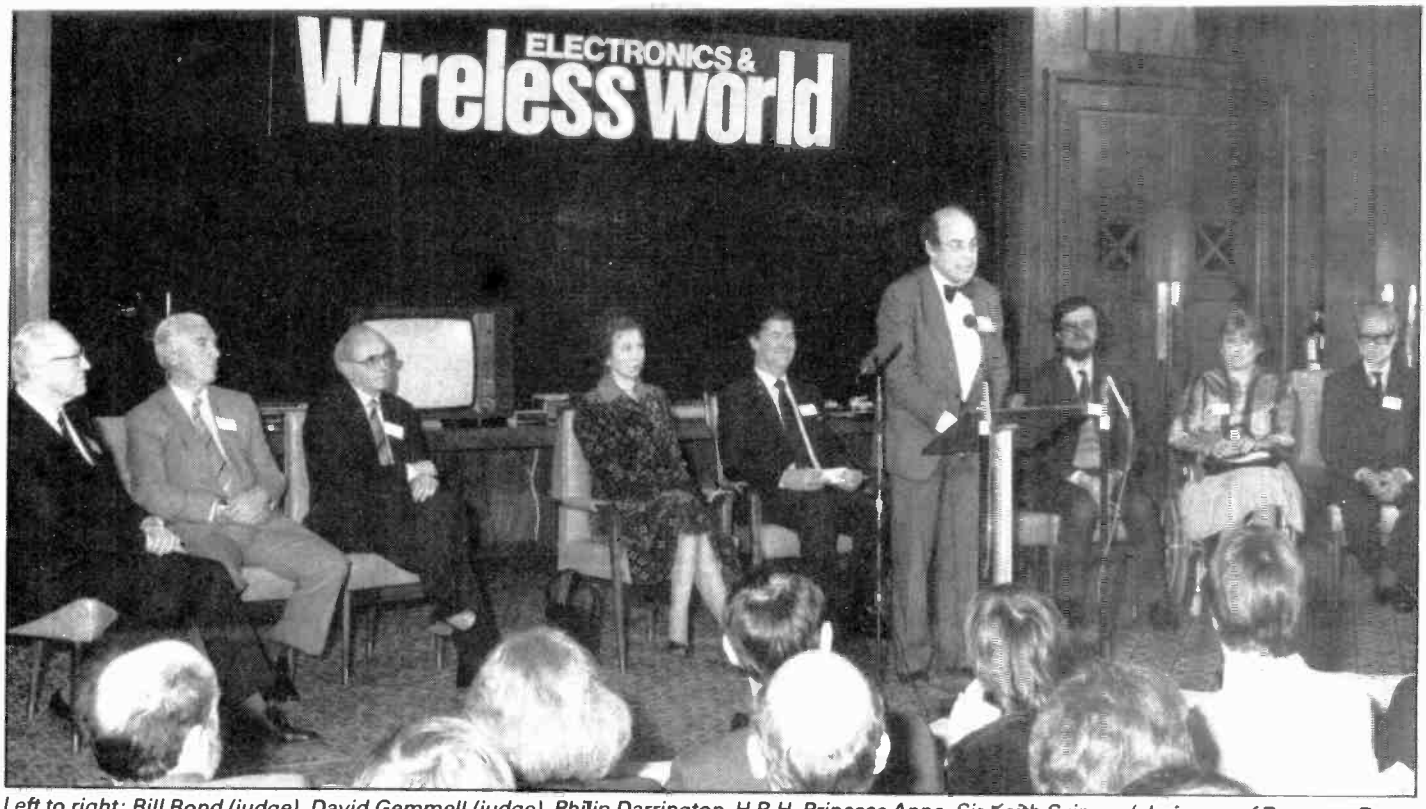

Left to right: Bill Bond (judge), David Gemmell (judge), Philip Darrington, H.R.H. Princess Anne, Sir Keith Skinner (chairman of Business Press International), Heinz Wolff (judge), Richard Lambley, Elizabeth Fanshawe (judge), Meredith Thring (judge).

Electronic devices for the disabled

First prize in Wireless World's recent competition was won by Tony Heyes of Nottingham University for his Sonic Pathfinder, a navigation aid for the blind. Dr Heyes received his award of £2,500 from Princess Anne at a presentation on January 30. Second prize, £1,500, went to Phil Pickersgill and Nic Stewart of Wokingham for a speech training device which they named Pausaid.

The four £1,000 prizes for runners-up went to

- David Battison and David Palmer of Cambridge, for their Miaphone, a speakback facility for blind, disabled typists.
- Michael Bolton and Alastair Taylor of Aberbeen, for their computer interface for the disabled.
- William McCarthy of Edinburgh, for his depth gauge for the visually handicapped.
- Ian Mitchell of Hull, for his Talking Box, a communication aid designed initially for speech-impaired children.

Judging and presentation of the awards took place on January 30th at the Institution of Electrical Engineers in London. Twelve entries selected for the final stage of the competition were demonstrated to the judges by their authors, who were Elizabeth Fanshawe of the Disabled Living Foundation, David Gemmell of Possum Controls Ltd, Bill Bond of the Polytechnic of the South Bank, Professor Heinz Wolff of the Brunel Institute for Bioengineering and Professor Meridith Thring, Queen Mary College, London University.

Princess Anne spent more than half an hour examining the devices and discussing them with their designers. In an address afterwards, she spoke of the ingenuity and inventiveness of those who had entered the competition. She said "Your enthusiasm and your efforts may not make you household names, but will certainly earn you the sincere gratitude of a highly individual and progressively independent group of people". Princess Anne spoke also of those who had not reached the finals, whose entries might still warrant development and possible future production. "If they do that", she said, "they will have their own reward".

Speaking on behalf of the judges, Professor Wolff praised the designers for their cost-consciousness. They recognised that technical aids had to be paid for by someone. "A competition of this kind as a stimulus for technically knowledgeable people to exercise their compassion and think about people less fortunate than themselves is itself very valuable".

An article by Dr Heyes describing his prize-winning entry will appear in *Wireless World* shortly, and we plan to include details of other interesting entries during the next few months.

Dr Tony Heyes receives his prize from Princess Anne.

Philip Darrington (right), Wireless World editor, with Dr Heyes and a Sonic Pathfinder. Left is Richard Lambley, projects editor.

Dr Michael Bolton (right) shows Princess Anne his computer interface.

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Differential temperature integrator

Battery-powered remote-reading integrating thermometer has application in energy-conservation schemes

R. Everett

As much as 25% of the UK's primary energy consumption is in domestic buildings, yet relatively little is known about the details of its use. Individual tastes vary wildly and variations of annual energy consumption of 3:1 or more between identical houses are quite common. Because of this, testing out some new insulation measure or heating system requires monitoring a large number of houses. This can be a very expensive business.

The traditional instrument for temperature recording has been the thermograph, a kind of clockwork chart recorder, still to be seen ticking away in the corners of art galleries and museums. More recently memory-based electronic recorders have appeared that can be read out into a computer.

For most housing work all that is required are weekly or monthly averages of temperature plus the opportunity to sample spot values, such as the evening living-room temperature. Most importantly, this must be done without disturbing the house occupants and without spending vast sums on cabling back to a central datalogger. The differential temperature integrator was specifically developed for the Pennyland field trial in Milton Keynes, one of many sponsored by the UK Departments of Environment and Energy in recent years, and involved monitoring 80 houses of varying insulation level and south-facing window area[1].

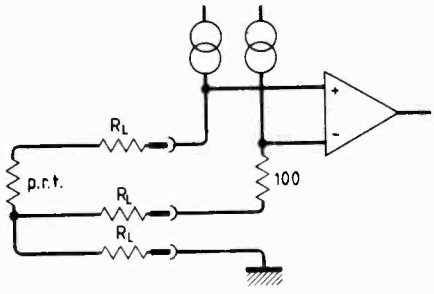

***Fig. 1.** Three-wire bridge circuit puts equal lead resistance in each arm, with one lead in common.*

Why a 'differential' integrator?

The heating energy consumption of a house is roughly proportional to the average inside-outside temperature difference (ΔT), the constant of proportionality being an indication of the insulation level of the house. To evaluate the effectiveness of insulation, weekly heating energy consumption needs to be correlated with weekly ΔT. We can extend the process to include solar radiation to make an estimate of the 'passive' solar gains into a house. ('Passive' as opposed to the 'active' solar energy that you get from solar panels.)

As various zones of a house are at different temperatures, a weighted average of the different temperatures of different rooms is required. Thus the job of the d.t.i. is simply to generate cumulative integrals of the difference in temperature between each of three sensors inside the house, two downstairs and one upstairs, and a fourth on the outside, preferably on the north side out of the sun's rays. The temperatures are sampled every 8 minutes and the cumulative integrals are clocked up on three liquid-crystal displays, in units of degree-days (i.e. 1degC for one day, commonly used in building work). For the Pennyland field trial the integrator was mounted alongside the gas and electricity meters in an external meter cupboard where it could be read by the researchers without entering the house. The d.t.i. also has a hold mode allowing any of the four temperatures to be sampled on a test point with a d.v.m.

This device is a logical solution to a monitoring problem; I was not surprised therefore to find a paper proposing such a device after completing the prototype[2].

Circuit design

The temperature sensors used are thin-film platinum resistance types (such as RS 158-238), effectively precalibrated to ±0.3degC. This type of sensor has a resis-

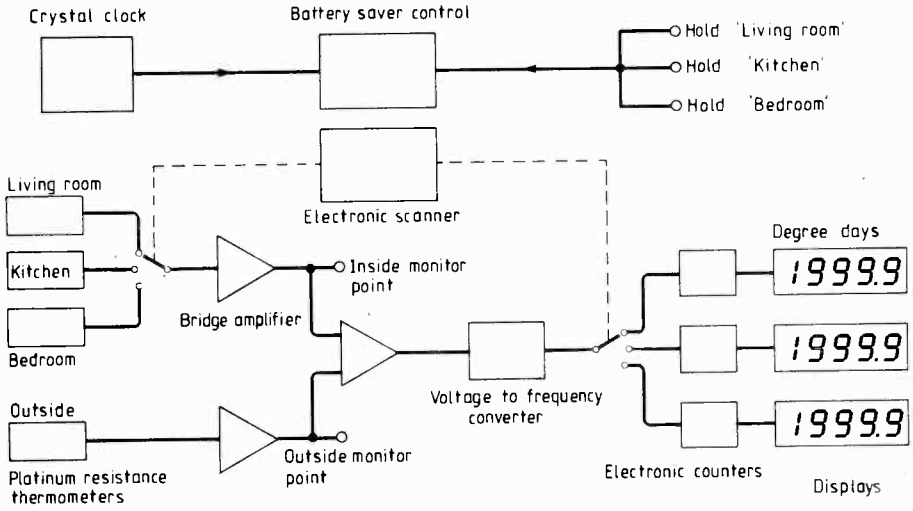

***Fig. 2.** Battery-saving circuitry samples temperatures every few minutes – the amplifier and v. to f. converter are multiplexed between sensors.*

Designed for temperature monitoring in energy conservation field trials at Milton Keynes this thermometer provides weekly average temperature differences between each of three zones of a house and the outside air temperature. Put crudely, heating energy consumption to a house is proportional to the temperature difference and the constant of proportionality is a measure of the quality of house insulation. The device requires three platinum resistance thermometers installed in the house, nominally one each in living room, kitchen and a bedroom, and an outside air temperature sensor. These four sensors are wired to the integrator box located in some convenient place, such as a meter or bin cupboard on the outside of the house, where it can be read weekly along with gas and electricity meters without disturbing the house occupants.

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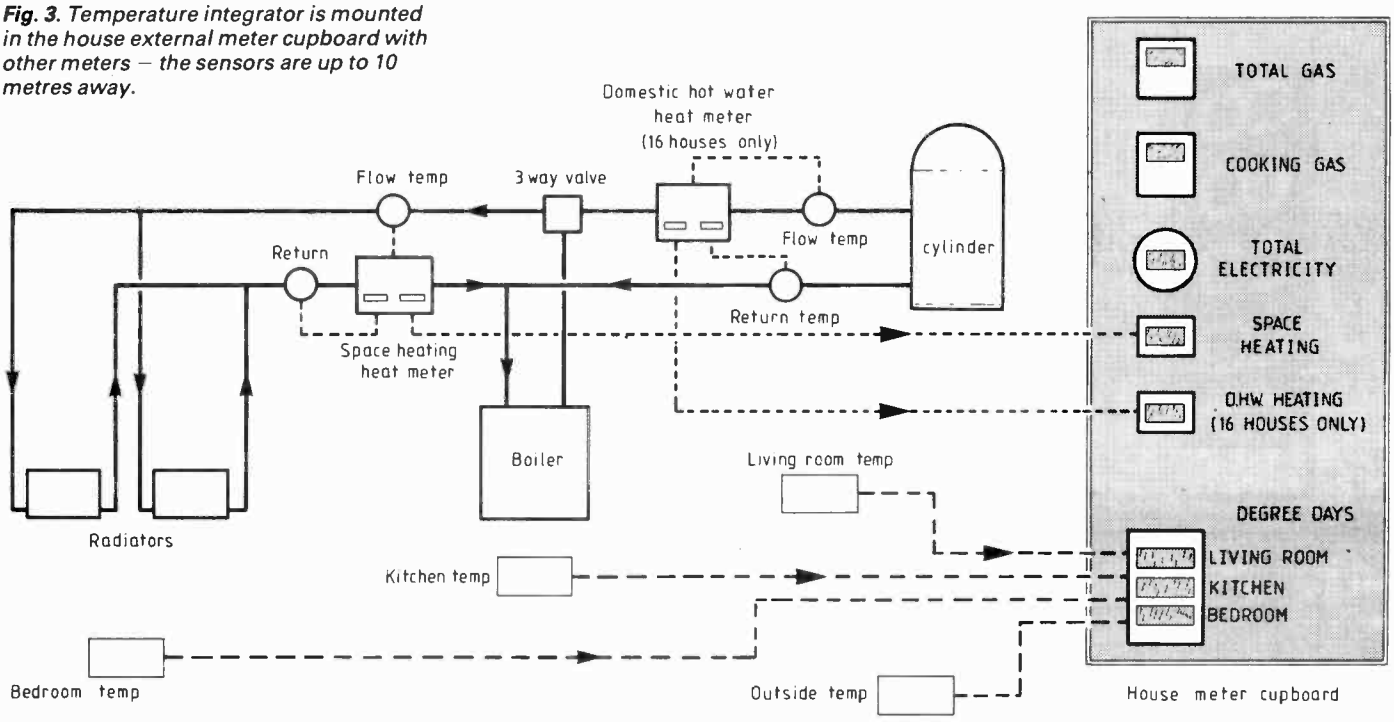

***Fig. 3.** Temperature integrator is mounted in the house external meter cupboard with other meters – the sensors are up to 10 metres away.*

tance of 100 ohms at 0°C rising to 138.5 ohms at 100°C.

Because lead resistances are likely to be significant it is usual to use them in a bridge arrangement, as in Fig. 1. Here the p.r.t. is compared with a precision 100 ohm resistor (e.g. RS158-086) and the bridge ensures that equal lead resistances appear in each arm, with one resistance in common.

I wouldn't recommend the use of i.c. constant-current sources in this type of bridge. Many have large temperature coefficients (read the fine print for long-term drift characteristics!) and more than one is sold as a dual-purpose constant-current source/temperature sensor! More recently, precalibrated thermistors have become available cheaply and these are now a better choice for temperature measurement than p.r.ts because of their higher output.

The temperature integration process is achieved by feeding the difference between the inside and outside temperatures to a voltage-to-frequency converter and then counting and displaying the resulting pulses. To minimize drift, the bridge amplifiers are ICL7600 commutating auto-zero types. To keep the component-count down the internal temperatures are multiplexed into a single bridge amplifier and v-to-f converter (see block diagram).

Much of the circuitry is devoted to battery saving. This allows four D-size and six AA-size alkaline cells to last up to six months.

The 32.768kHz crystal oscillator is counted down by 4040 counters and decoded with the 4068 and gate to wake up the sleeping system for two seconds in 512 (about eight minutes). In the off state, battery consumption is essentially that of the three liquid crystal displays (about 300μA). The circuit cycles through four phases of 500ms each, starting with a settling period with the amplifier inputs grounded. Then each of the sensors in turn is routed through the input multiplexer and the bridge amplifier to the v-to-f converter. The resulting pulse train is routed to the appropriate 4040 counter and 7224 counter/display driver.

The v-to-f converter (Teledyne 7400 or RS307-070) requires a stabilized negative voltage rail as a reference, the stability of

Designed by Bob Everett and engineered by the OU Electronics Common Facility, 100 of these temperature integrators were made and installed in houses at Milton Keynes in the summer of 1981.

Bob Everett is currently a Research Fellow in the energy research group of the Open University. He studied mechanical and electrical engineering at Cambridge University, graduating in 1970, and subsequently worked on computer phototypesetting development for the (then) International Publishing Corporation. Since 1976 he has worked on the monitoring and computer analysis of a number of solar energy projects in Milton Keynes. He is embarrassingly fond of his ZX81.

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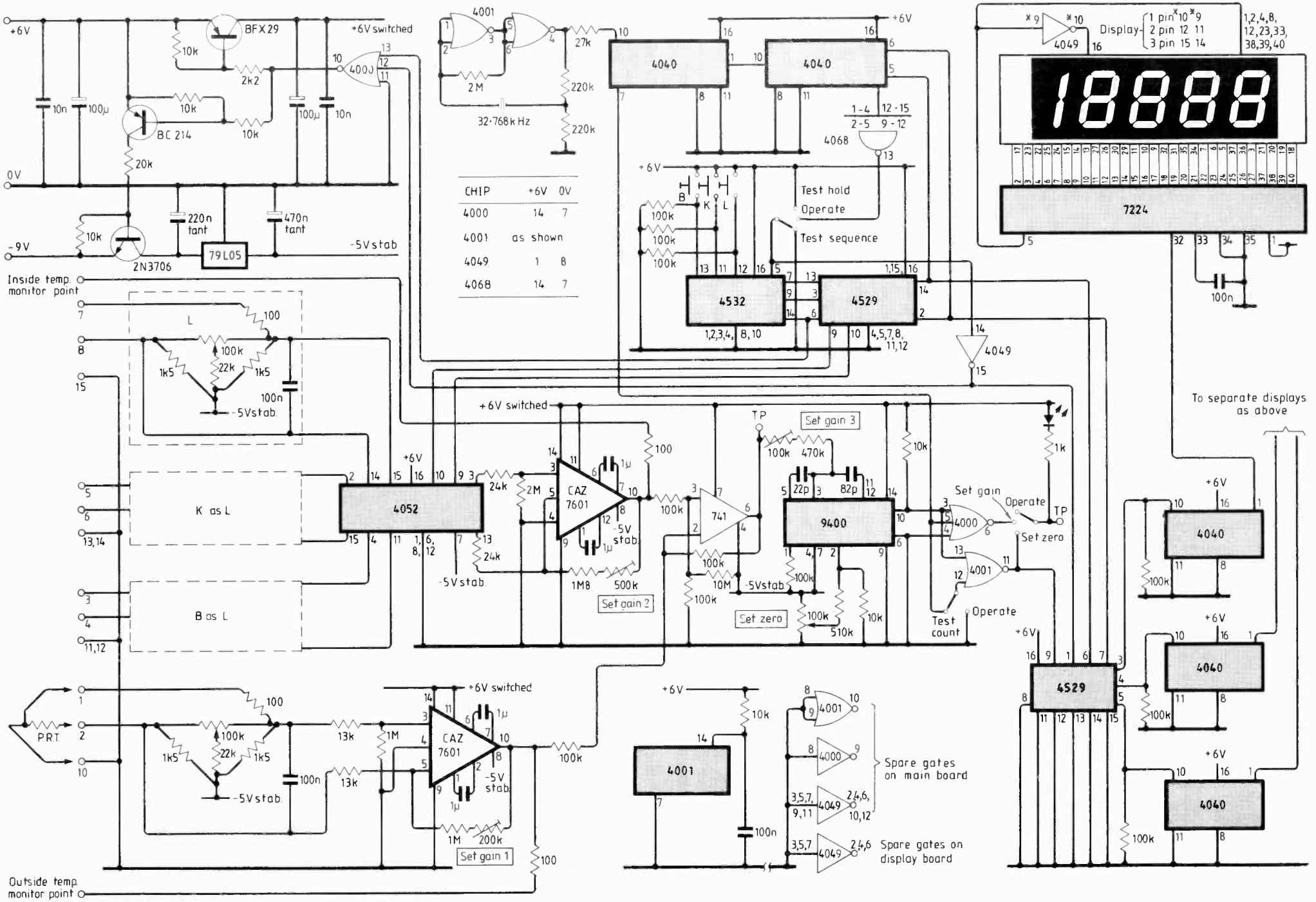

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◀ *Fig. 4. Light-emitting diode and associated switches were included for production testing and could be omitted. The l.e.d. was an idea to set the v. to f. converter gain without an oscilloscope by beating the output against the crystal clock, but the 'scope is a lot easier in practice.*

the positive rail being not nearly so critical. Hence the use of a 9V battery regulated to 5V to drive v-to-f converter, bridge amplifiers and the bridge.

Pressing any one of the individual hold buttons powers the system. The 4532 priority encoder selects the appropriate two-bit address and also allows the normal integration mode priority should the counter time out. The bridge amplifiers are powered and the appropriate temperature can be sampled on the two test points with a d.v.m. (1 volt≡10degC).

Setting up

The design contains a rather confusing array of switch settings for testing and setting up, most of which turned out to be unnecessary. The bridge amplifier gains and offsets can easily be set up in the hold mode using standard resistors (100Ω≡0°C and 110Ω≡26.0°C). The v-to-f offset is set to give a 5Hz tickover at zero ΔT (visible on the l.e.d. in the set-zero switch position). The v-to-f gain is set by adjusting the output to 8.192kHz at a ΔT of 16.9°C. The beat between the v-to-f output and the reference signal from the clock chain should be visible on the l.e.d. with the test switches set to set-gain. Alas, in practice it is far more visible on a 'scope.

One vital ingredient missing from the design is a way of detecting leaky c-mos chips. With complex battery powered equipment, one leaky chip or a floating gate can mean the difference between microamps and milliamps of battery consumption. But which chip is it? Desoldering them at random from a double-sided printed circuit board is a recipe for disaster, and yet a few 100ohm resistors in the power rails to localize the fault could have saved many boards from the bin.

This design dates from 1980. A production run of 100 were made in 1981 and have performed reliably since then. With the close of the Pennyland field trial they are likely to be passed on to further trials. Although the design is a little dated, it is still difficult to get the same performance at the price from a micro design (the components excluding board and box come to about £120), but it it is only a matter of time.

Members of the Open University Electronics Common Facility transformed the scruffy prototype into a production device. Funding for the Pennyland project came from the Department of Energy, through their Passive Solar Energy Programme, and the Department of Environment as an extension of their 'Better Insulated House' programme.

References

1. Energy Projects in Milton Keynes, S. Fuller, J. Doggart & R. Everett, 1982. Available from Milton Keynes Development Corporation.
2. Simple data-logging instrumentation for monitoring the thermal performance of buildings, Charles Newcomb, Proc. 5th Passive Solar Conference, University of Massachusetts, 1980.

Adaptable typewriter interface

continued from page 28

Table 1. Small sample of the output of program of List 1.

Data to printer	*Ascii decimal equivalent*
12	*82*
13	*77*
14	*64*
15	*75*
16	*94*
17	*94*
18	*80*
19	*83*
20	*87*

Notes and limitations

Some residual problems exist such as the fact that the ascii code does not allow for characters such as half-space or ÷ which are available from the typewriter keyboard. One possible solution to this is to define characters in the code range 128 to 255 and then to use software to substitute these special codes when the alternate character set is required. A decision to include or discard such codes will have a bearing on the complexity of your final program as will, for instance, forcing your non-proportional spacing typewriter to right-margin justify text.

Note that the Praxis does not seem to read the keyboard 1/keyboard 2 status unless the character buffer is empty and so it is necessary to delay before changing the keyboard status if the printing rate is above about ten characters per second.

A more serious limitation is the amount of time that the printer can run continuously until it needs a cooling off period. Typewriters are seldom driven by people who type virtually continuously and so they tend to overheat with this kind of use. For example the Praxis is not really up to printing more than 40 minutes continuously without say a 20 minute rest for the mechanism to cool down a bit. If the printer does get overheated it tends to skip characters and generally mess up the text, thus necessitating a reprint. A lot of printing can be done in 40 minutes but for really long and hard use it is probably more effective to purchase a heavy-duty daisy wheel printer in the first instance.

The problem of feeding single sheets of paper into the printer can be overcome either by forcing a software delay (the simplest method) at the start of each new page or else detecting the form feed character, then setting a latch to hold BUSY high until manually reset.

There are of course plenty of hardware options to add on if desired. A uart can be added to accept serial input but be careful about drawing too much current from the printer power supply. A preprogrammed eprom inserted into the data lines will enable the printer to accept straight ascii character data rather than the modified set used here. By this stage you are probably considering one of those single-chip eprom-based processors to produce an interface with all the 'bells and whistles'.

Table 2 shows the ascii code in binary for a character (written in left hand side of column) and decimal data representation of the binary code to be sent to the printer (right hand side). For example ascii code 1100100 is found from intersection of column 100 and row 1100 giving character 'd' translated to decimal code 123 for the printer. Non-printing characters are shown by blank entries.

Bits 7654	321 000	001	010	011	100	101	110	111
0000	nul							bel
0001	bs 114	ht 70	uf	vt	ff	cr 48	so 71	si 98
0010		dc1 68	dc2 67	dc3 65	dc4 66			
0011				esc 96			rs 69	
0100	sp 113	! 154	" 22	# 158	£ 54	% 29	& 52	' 40
0101	(8	) 56	* 30	+ 26	, 125	- 80	. 85	/ 62
0110	0 120	1 94	2 86	3 126	4 78	5 118	6 110	7 116
0111	8 104	9 72	: 23	; 87	< 8	= 90	> 56	? 144
1000	@ 14	A 27	B 53	C 57	D 59	E 60	F 11	G 41
1001	H 55	I 10	J 47	K 15	L 63	M 13	N 45	O 58
1010	P 18	Q 28	R 12	S 19	T 44	U 42	V 9	W 20
1011	X 17	Y 43	Z 25	[8		] 56		46
1100	Y 40	a 91	b 117	c 121	d 123	2 124	f 75	g 105
1101	h 119	i 74	j 111	k 79	l 127	m 77	n 109	o 122
1110	p 82	q 92	r 76	s 83	t 108	u 106	v 73	w 84
1111	x 81	y 107	z 89	8	| 157	56		

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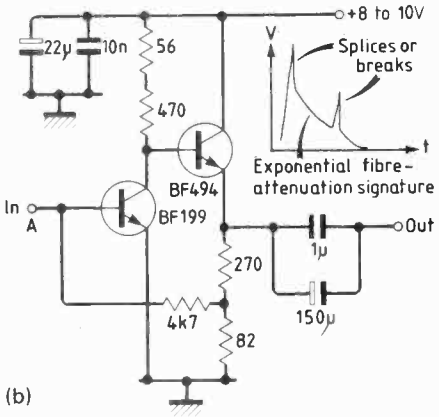
CIRCUIT IDEAS

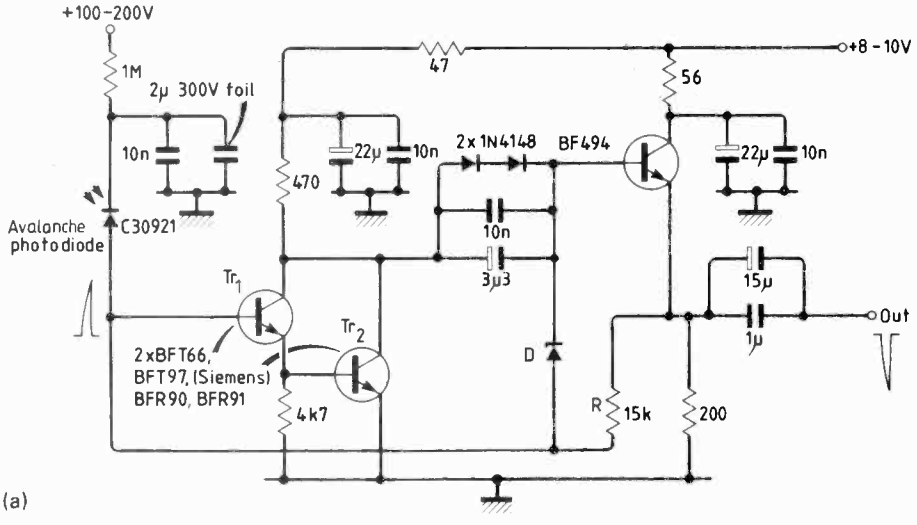
Optical-fibre measurements

Used with an optical-fibre directional coupler, these circuits allow backscatter measurements on fibres with >10dB one-way insertion loss. Light pulses of 50ns are used in the avalanche photodiode pre-amplifier which, when carefully constructed, has a 10-40MHz bandwidth. Small-signal Schottky diode D stops $Tr_{1,2}$ saturating when strong optical reflections occur. Resistor R should be as high as possible, depending on the required bandwidth. When displaying fibre backscatter curves on an oscilloscope, the second amplifier circuit may be useful (b). Oscilloscope bandwidth should be equal to or greater than 40MHz.

In the GaAs laser-diode pulse circuit, (c) capacitor C charges through the transistors and is discharged through the Siemens fast-recovery thyristor and the RCA SG2004/5/6 laser diode. These 904nm laser devices suit the C30921 avalanche photodiode. Capacitor C, chosen to give 50% light-on time, depends on the laser diode and supply voltage and is typically around 8nF. Pulse repetition rates higher than 10kHz are possible. Using a ferrite pulse transformer to drive the thyristor provides isolation (shown separately).

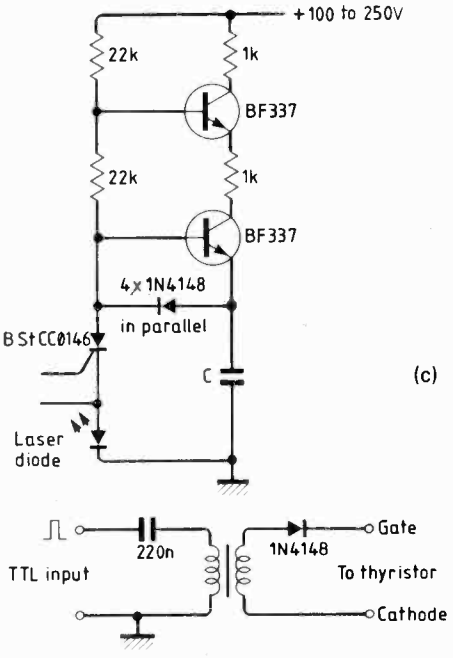


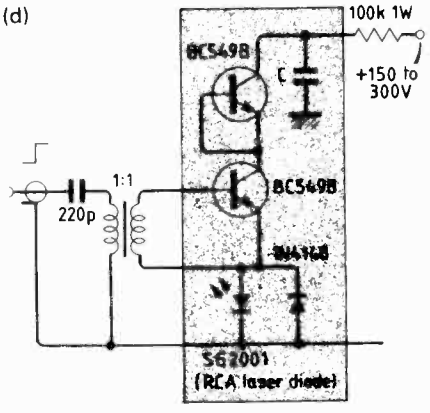
(b)



(a)

As an aid to optical-fibre bandwidth measurement, final circuit (d) can produce light pulses as short as 200ps with capacitor C at 45pF and using selected transistors in avalanche mode. Input pulse-repetition frequencies between 100Hz and 100kHz

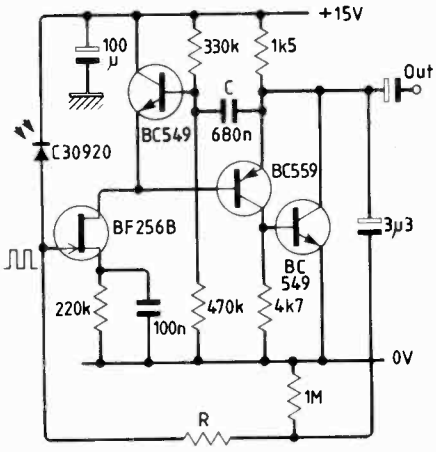




are possible. Siemens BC549s showed avalanche effect at V_{CEO}>70V and $V_{(BR)CES}$>140V d.c. Each of the transistors must be above these limits and only small-signal devices may be used. Wiring within the boxed section should be as short as possible.

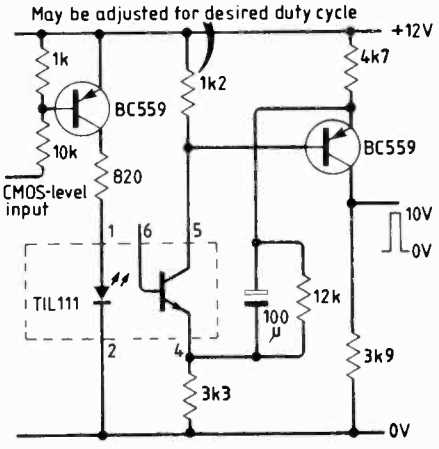
Chopped-light amplifier

Filtering the output of this amplifier to within 100Hz of the chopping frequency of say 1kHz allows light levels down to 10pW to be detected when R=10MΩ. A bipolar transistor fixes the fet drain voltage so



selection is not required; drain current may be altered by adjusting the source resistor. Voltage gain of the fet is high through inclusion of capacitor C which provides a high dynamic-load impedance. Amplifier noise is 0.04pA r.m.s./√Hz and noise of the RCA C30920 p-i-n diode is 0.06pA r.m.s./√Hz.

Schmitt-trigger opto-coupler



J. Vandewege
Ghent University
Belgium

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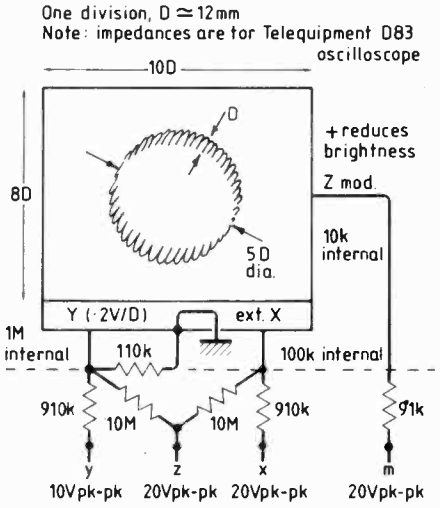
Aligning four frequencies

Four a.c. signals may be compared on a four-channel oscilloscope, but a more graphic representation can be obtained using an oscilloscope in XY mode and adding pseudo-Z and Z modulation signals. This is particularly useful when testing phase-locked loops or tuning several signals simultaneously.

This arrangement, originally devised for a Telequipment D83 oscilloscope, was used to set up two 50Hz sinewaves in quadrature (at x and y) by means of a Lissajous circle. A 2.5kHz signal introduced at z causes the circle to take on a crown shape; this signal appears stationary when its frequency is an exact multiple of the fundamental signal. The highest frequency, 5kHz in this instance, is applied at m to modulate brightness and results in a stationary stripe when synchronized.

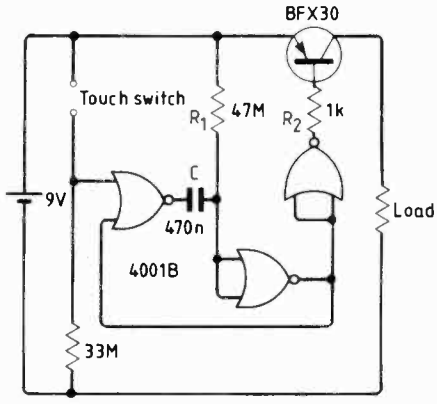
With practice, z and m can be adjusted simultaneously. For lower multiples applied to z characteristic shapes are obtained, i.e., three lobes at 2f and four lobes at 3f. If frequencies at x and y are not the same, as usual, Lissajous figures are stationary when the frequencies are exact multiples of each other. For digital signals, sensitivity may be increased by reducing series-resistor values.

C. J. D. Catto
Cambridge



Simplified battery timeout

This contribution is a cheap and simple means of conserving battery power using only six components. After the touch switch is activated, power is applied to the load for a period equal to $0.69CR_1$. Resistor R_2 determines current limiting and may be changed. Quiescent leakage current is less than 100nA and with values shown, the power-on period is 13s and current limiting is at about 450mA. At 200mA, voltage drop is only 200mV.



S. Whitt
Ipswich
Suffolk

Programmable pulses with delay

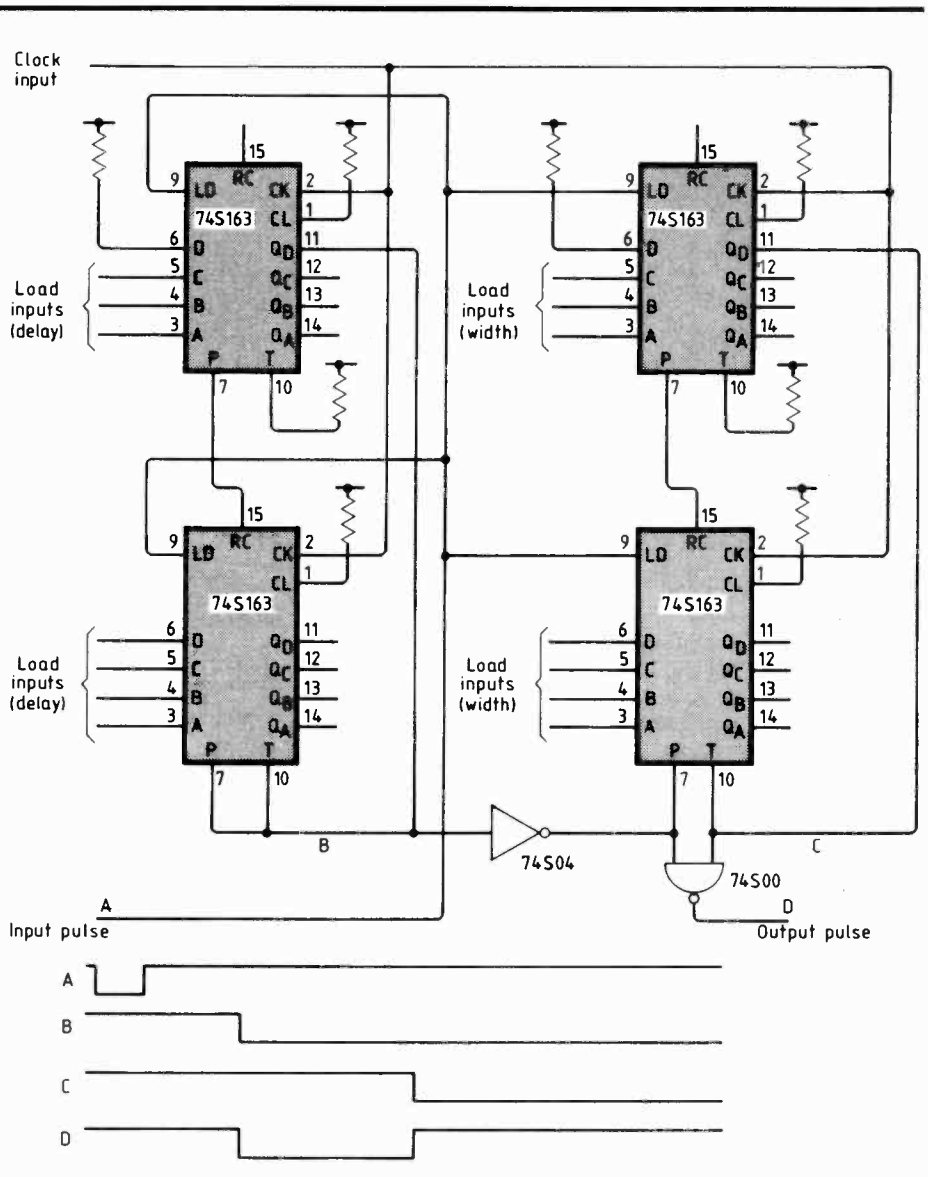
On triggering, this programmable circuit produces a pulse after a delay. Accuracy of the pulse and delay periods is determined by the accuracy of the clock so the design doesn't suffer from drift associated with monostable circuits and works reliably at high frequencies.

The first counter determines delay and the second one pulse width. Counter Q_D outputs are used as these change synchronously with the clock and don't produce glitches at the output but it means that the maximum count is half of that possible using the ripple-carry output. Eight-bit counters are shown but any number of bits may be used by cascading more or fewer 74S163 i.cs. Delay D for a load value L is given by

$$D=(2^n-1)-L$$

where n is the number of counter bits. In this case, n is seven.

A. D. Hacket
Salisbury
Wiltshire



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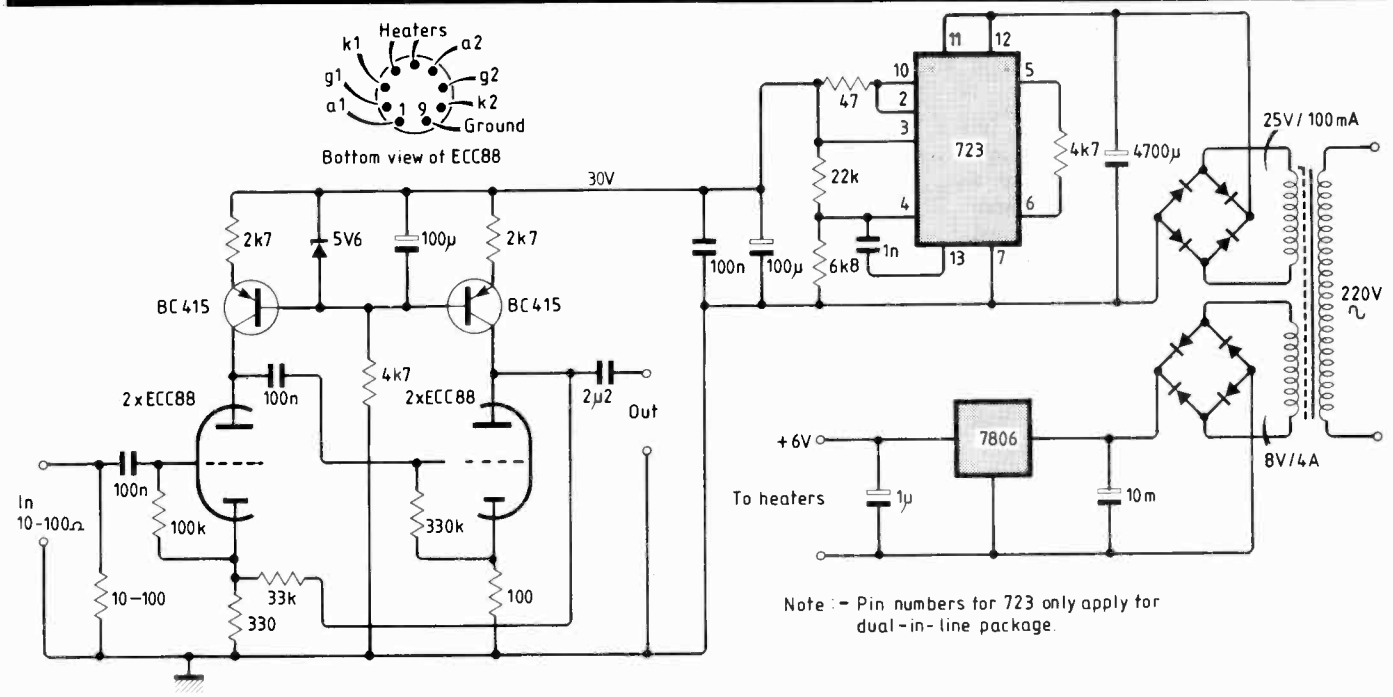
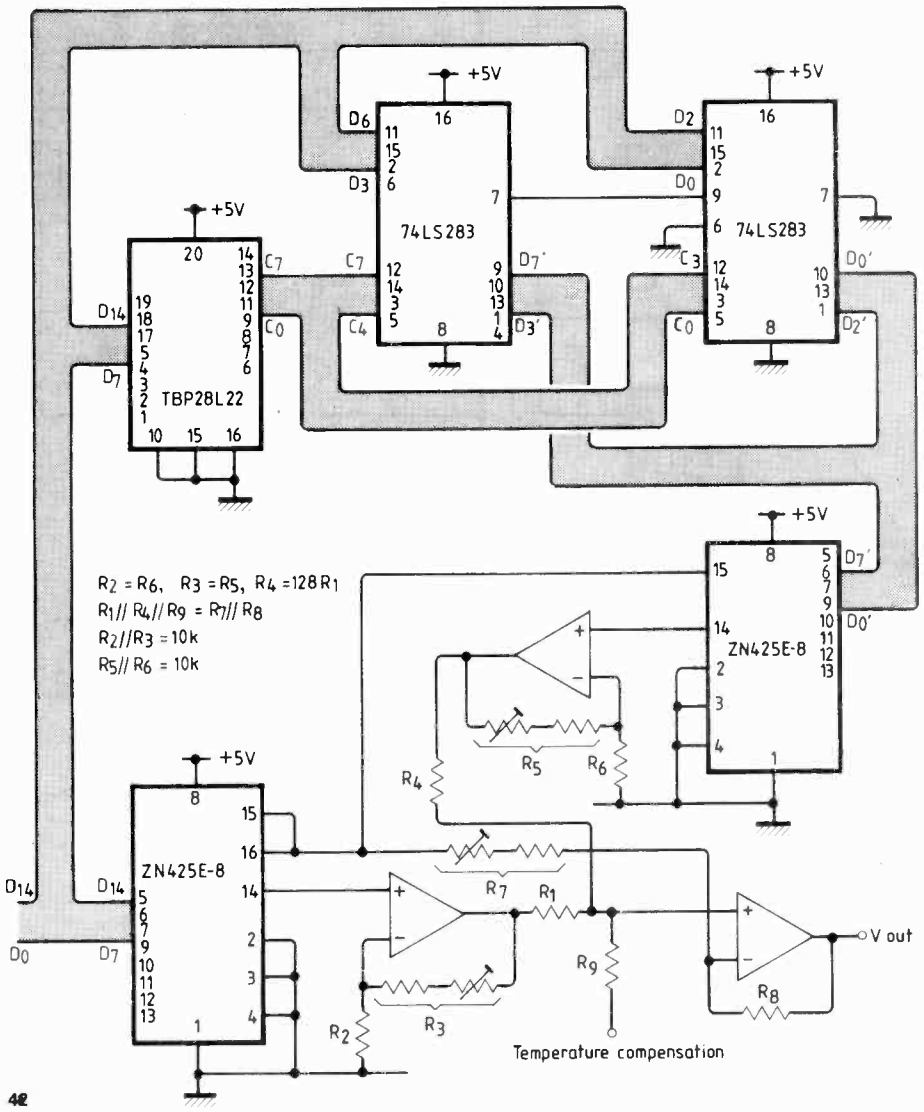


Moving-coil amplifier

I find that this moving-coil cartridge amplifier using valves gives a more natural sound than many circuits using transistors and it is easy to construct. Anode voltage rating of the ECC88 dual triode is only 90V but it may be taken as low as 10V so power-supply design is simplified. The two sections of each ECC88 are connected in series and low-noise transistors connected as constant-current sources form anode loads for the two stages. Gain of each stage is about 30.

A 723 regulator is used for the main supply because signal-to-noise ratio of the amplifier depends on noise, output impedance and ripple rejection of the supply. Popular 78-series regulators are not good enough. Valve heater supply must be regulated for the same reasons but in this case a 7806 suffices. Overall closed-loop gain of 100 is determined by the 33kΩ resistor, which may be lowered to reduce gain. Open-loop gain is 600. Loading required for different makes of cartridge varies but is usually between 10 and 100Ω. Capacitors are critical and high-quality polycarbonate or polypropylene types should be used throughout, except for power-supply smoothing.

Per Hojlev
Copenhagen
Denmark



15-bit d-to-a using ZN425 converters

Two cheap eight-bit d-to-a converters are combined to form a 15-bit converter in this circuit. Output of the left-hand converter is calibrated for all input values (0 to 255) and a correction value is programmed into the 28L22 prom with 00 corresponding to −511/512 l.s.b. and FF_{16} corresponding to +511/512 l.s.b. This correction is added to the seven least-significant bits of the input data to provide an eight-bit input to the second converter. Reference voltage for both converters is derived from one i.c. to reduce errors due to ageing and temperature fluctuations.

Resistors $R_{3,5}$ are adjusted to give correct scaling factors for the two d-to-a converter outputs and R_7 corrects for output offset. Component values are not shown since these will depend on the application and output voltage range required. Temperature compensation can be applied through R_9 and by using an external reference voltage.

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Merseyside

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The parallel-fed voltage multiplier

Although any desired voltage may be obtained by stringing together a sufficient number of cells, a voltage converter has many advantages. Battery testing and replacement are simpler, and there is the option of using a single rechargeable device to power the whole of the circuitry.

R. D. Purves and C. Prescott

Our particular need arose during the design of a portable muscle stimulator for biomedical use. The initial specification called for a unit to give output pulses at 10Hz, of 200μs duration and amplitude 15mA maximum into a load of approximately 8kΩ, representing the resistance of electrodes placed on skin over the muscle. The stimulator was to be carried about in a pocket or on a belt, and would be used for 6 to 12 hours per day. The power source was to be a single PP3 9V battery, and we hoped to keep the current drain below 1mA to ensure long battery life.

The specification evidently requires a voltage supply of at least 120V. As the output energy per pulse is 0.36mJ, the average power drawn from the supply is 3.6mW. If voltage conversion could be achieved with 100% efficiency, the current drain from the battery would be only 0.4mA. Thus the target value of 1mA seemed approachable. However at power levels below 10mW a conversion efficiency of even 50% is hard to achieve, as we found by examining a commercial stimulator with broadly similar specifications. It employed the conventional oscillator and step-up transformer, rectifier approach to voltage conversion, and its current drain was several milliamps. This poor efficiency, less than 20%, encouraged us to consider an alternative method.

Fig. 1 shows the well-known Cockroft-Walton cascade voltage multiplier in the form commonly used when an alternating voltage is available to drive it. A minor modification at (b) enables it to be driven by antiphase square waves which do not have to swing below 0V. These circuits are series-fed: the a.c. or square-wave driving voltage is applied to the end of a chain of capacitors in series. Design and analysis are notoriously difficult, because the current and voltage waveforms for each stage are different. It is known that with optimal allocation of resources the capacitor values should not all be equal, but should increase from C at the output end to NC at the driven end. Another disadvantage is that the additional output voltage per stage is not constant, but diminishes by one diode drop V_f for each stage in the circuit.

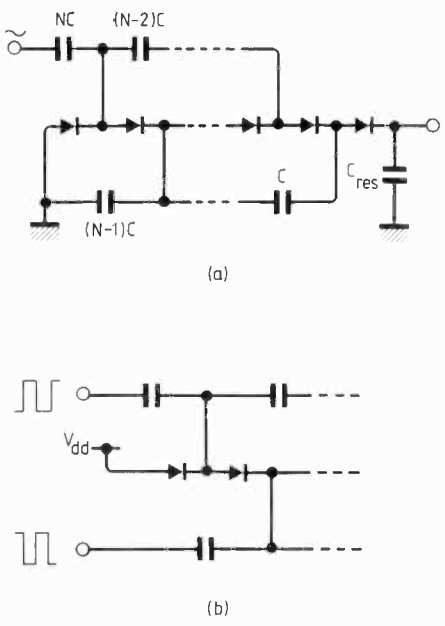

Fig. 1. In the Cockroft-Walton series-fed voltage multiplier the output reservoir capacitor C_{res} is chosen to have a reactance, that is much less than the load impedance at the working frequency. (a) is the single-ended version, while (b) is a modification for push-pull input where antiphase square waves do not have to swing below 0V.

Thus in Fig. 1 (b) with a driving swing from 0 to V_{dd} of 9V and V_f taken as 0.6V, one stage provides 9+8.4=17.4V, two stages provide 9+8.4+7.8=25.2V, and so on up to 14 stages which provide 72V. Beyond this limit extra stages contribute nothing.

While pondering these deficiencies we discovered that some remarkable improvements result if the configuration is changed to the parallel-driven form of Fig. 2. The N capacitors now all take the same value, which simplifies construction. The open-circuit output voltage per stage has the constant value $V_{dd}-V_f$ and so the total output voltage $(N+1)(V_{dd}-V_f)$ can be increased without limit. Finally, the analysis is facilitated by the fact that apart from a step-wise increase in d.c. level, the current and voltage waveforms for each stage are identical (this is strictly true only if N is even, so that points X and Y see the same total capacitance).

The most important design parameter of a power supply, after its open-circuit output voltage, is the equivalent output resistance. The parallel-fed multiplier's output resistance can be derived directly as the ratio of open-circuit output voltage to short-circuit output current. For calculation only, it is convenient to return point Z of Fig. 2 to earth instead of to V_{dd} and to treat the diodes as having zero forward voltage drop. With these assumptions the output voltage becomes NV_{dd}. A further assumption, which will later be relaxed, is that square wave sources X and Y have negligible internal resistance and thus provide a full swing from 0 to V_{dd} regardless of the load. Now if the output terminal is earthed the diodes and capacitors act in 'bucket brigade' fashion to transfer a charge CV_{dd} from one stage to the next in each cycle. The average short-circuit current is therefore CV_{dd}/T where T is the square-wave period; it follows that the multiplier output resistance is NT/C.

A more general expression for output resistance, derived in the appendix, is

$$(NT/C)\coth(T/2NRC)$$

in which the hyperbolic term corrects for the finite resistance R of the square-wave

continued on page 45

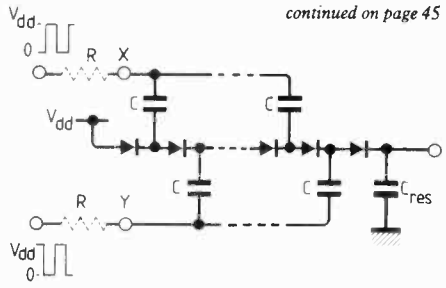

Fig. 2. Parallel-fed voltage multiplier. Resistors R represent the equivalent resistance of the square wave sources.

Dr Purves is with the department of pharmacology, University of Otago, New Zealand, and Mr Prescott is at the department of anatomy & embryology, University College, London.

* Battery-powered instruments, by Ian Hickman, *Wireless World*, vol. 87, 1981, pp.57-61.

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Frequency response analyser

Using an oscilloscope to display response, this educational aid to understanding frequency response of amplifiers and tuned circuits covers the band 40Hz to 400kHz.

by K. Srivatsa, R. Partha and S. L. Sridharmurthy

The heart of the analyser is a voltage-controlled oscillator, Fig. 1, whose ramp voltage varies the frequency. The v.c.o. used, the Intersil 8038, has a linear relationship between control voltage and frequency with the required range of 1:10,000 covered in four sweeps, each sweep causing a decade change in frequency. A given frequency range depends on external resistances and a capacitor. In our scheme, four different timing capacitors are used, one for each sweep range, switched in a repetitive sequence. The switching circuit shown in Fig. 1 is also used for providing retrace pulses for the bootstrap ramp generator and external trigger input for stabilized oscilloscope display. For a large frequency sweep, the v.c.o. requires a control voltage decreasing from V_{max} to V_{min} of V_{cc} to $2V_{cc}/3 + 2$. The level shifter with inversion after the ramp generator shown in Fig. 1 solves this problem.

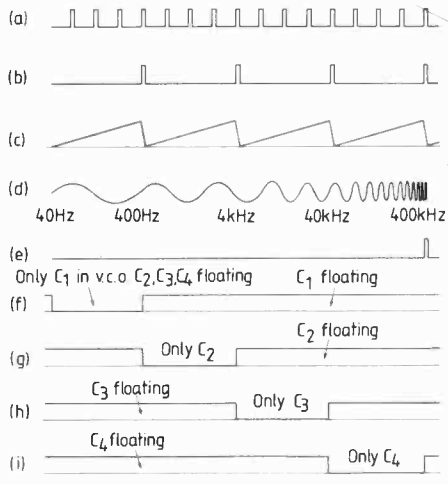
The v.c.o. output is attenuated and fed to the input of the device under test (d.u.t.), say an RC-coupled amplifier. The frequency-dependent output of the device under test is passed to the oscilloscope Y-input.

K. Srivatsa, with a B.E. and M.Tech. in electronics, lectured at the University Visvesraraya College of Engineering, Bangalore, before becoming senior engineer (software) at Processor Systems Pty Ltd, Bangalore. His co-authors graduated from UVCE in 1982 with B. E. (Electronics) and have taken up jobs in power electronics (Sridhara Murthy) and digital microwave communication (R. Partha).

Figure (2a) shows the clock input to the switching circuit, with a duty cycle of about 10%. Waveform (b) is derived from (a) with a period equal to four times the clock period. These pulses are passed to the bootstrap ramp generator circuit causing retrace.

The ramp at (c) has a frequency of 400Hz. This waveform is inverted and level shifted before the v.c.o., whose output is shown in (d). Waveform at (e) has a period of four times the ramp period used for external sweep triggering to give a flicker-free display. Waveforms (f) to (i) switch the required capacitor into the v.c.o.

Fig. 2. Waveforms (a) to (f) are found at the nodes 1 to 6 in Fig. 1.



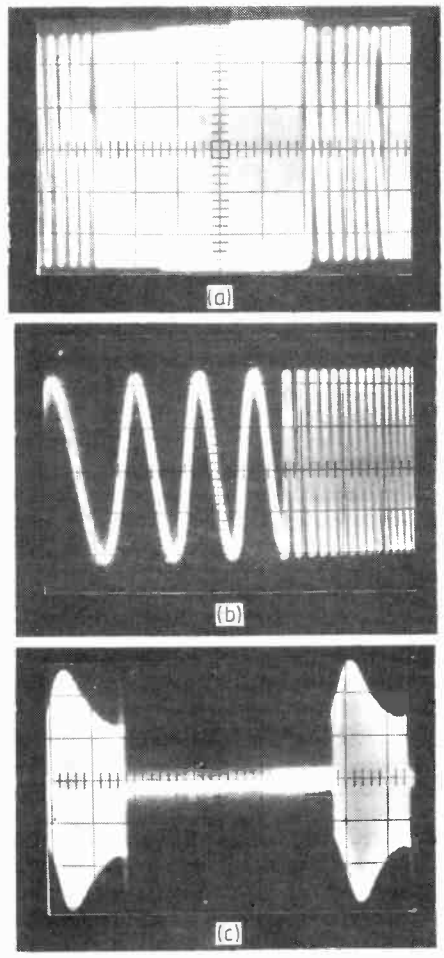
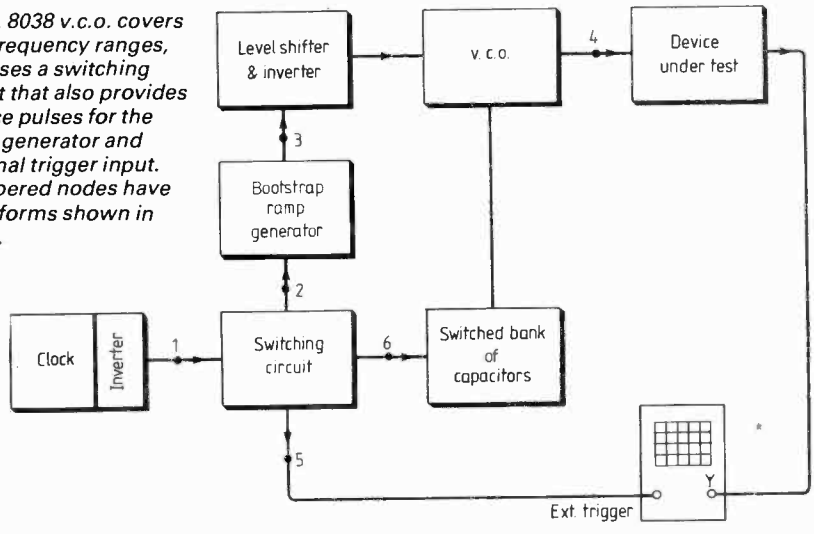


Fig. 3. Full range of analyser is shown at (a), with an expansion at (b). Lower trace shows typical output from a tuned amplifier.

Fig. 1. 8038 v.c.o. covers four frequency ranges, and uses a switching circuit that also provides retrace pulses for the ramp generator and external trigger input. Numbered nodes have waveforms shown in Fig. 2.



The performance of the analyser is demonstrated in Fig. 3. Photograph (a) shows the full range of v.c.o. and (b) is an expanded partial range. With this was the input to a tuned amplifier, the resulting output was as shown in (c). The detailed circuit is shown in Fig. 4. Design procedure is easily obtained from the data sheets[1].

Improvements

For higher resolution, as in a tuned amplifier which requires a part of the frequency

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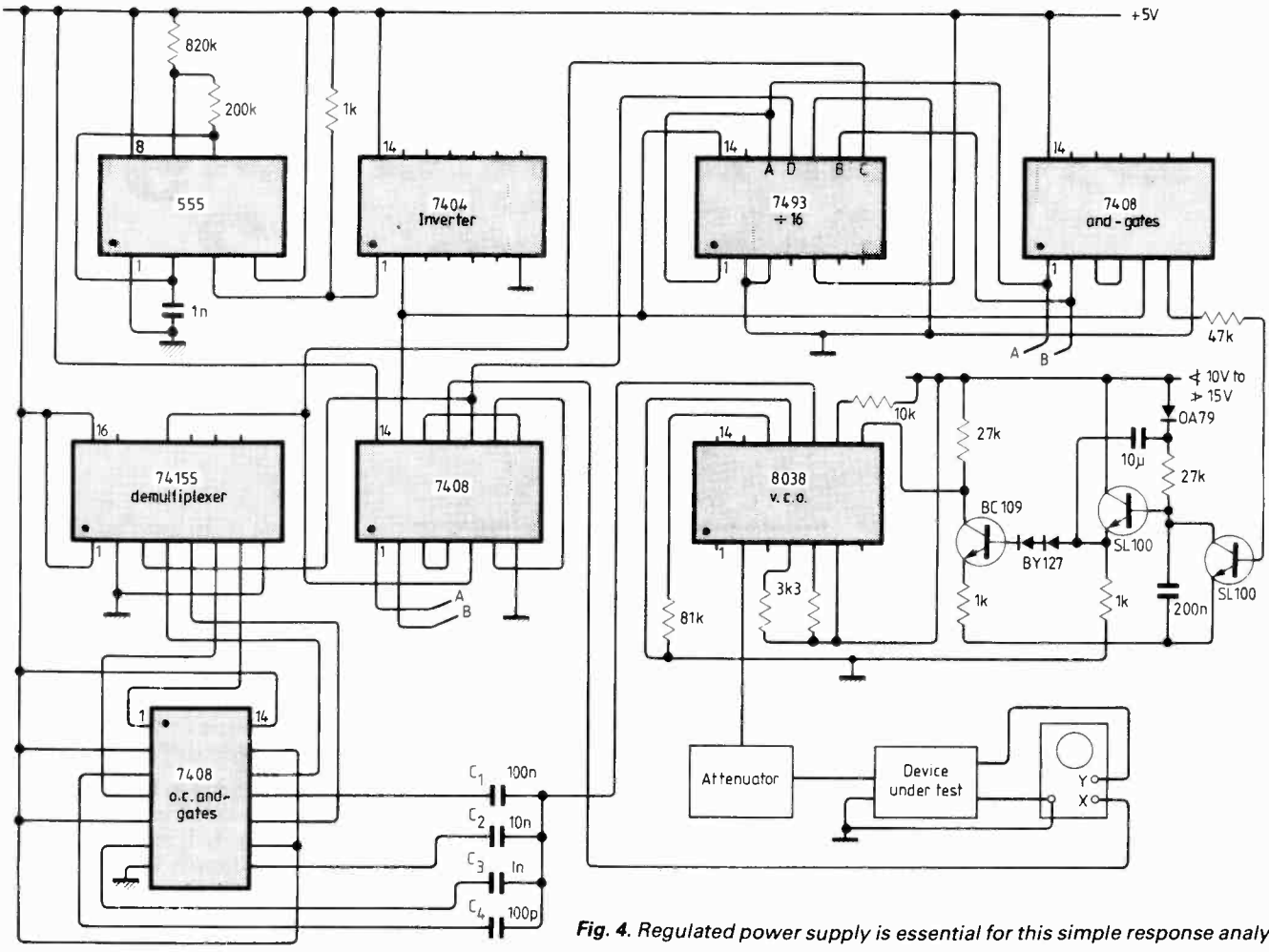

Fig. 4. Regulated power supply is essential for this simple response analyser.

range, it must be possible to divide the entire sweep range into programmable sub ranges, and the above multisweep technique repeated within each sub range.

In the analyser, the sinewave output of the d.u.t. is fed directly to the Y input. For a proper plot a direct voltage must be given to the Y input. It will be necessary to use a wideband average detector with a switched filter for a d.c. output. Switching of filter capacitors is done using the waveforms for switching the v.c.o. capacitors. Other techniques for improving the display can be found in reference 2.

References

1 Intersil application note ICL 8038.
2 Logarithmic audio sweep generator, by A. C. Ainslie. *Wireless World* Sept. 1979.

Parallel-fed voltage multiplier

continued from page 43

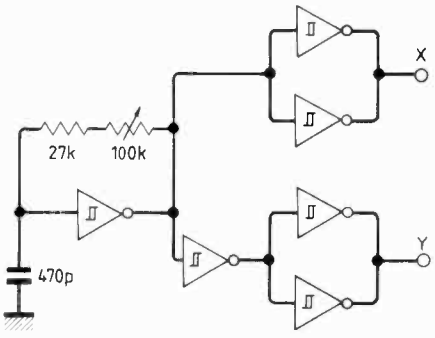

Fig. 3. A simple low power square wave source, using a CMOS hex Schmitt inverter (40106B or 74C14).

sources. For fixed R the output resistance falls with decreasing T or increasing C until $T \ll NCR$, when a limiting minimum value $2N^2R$ is reached. The actual value of capacitance used is largely immaterial, as a compensatory change in T can always be made.

In low power operation c-mos gates have sufficiently low output resistance (a few hundred ohms) to act as drivers, especially if two or more gates are parallelled, Fig. 3. More effective buffering is needed at power levels greater than about 10mW. A 15-stage multiplier driven by this circuit with T=50µs and C=10nF provided an open-circuit voltage of 137V with a battery drain of 0.27mA. The measured output resistance was 130kΩ. With 30µA drawn from the output, total battery drain was 0.72mA. Overall conversion efficiency (load power/battery power) is 60%, a very satisfactory result in view of the low power level. If miniature polyester layer capacitors are used in the multiplier chain the entire circuit occupies little more volume than the 9V PP3 battery supplying it.

Appendix

When the resistance R of the square-wave sources is not negligible, the waveform at X or Y with the multiplier output short-circuited takes the shape indicated in Fig. 4, in which the amplitude of the swing V_2-V_1 is less than its maximum value V_{dd}, owing to incomplete charging and discharging of the capacitors in each half cycle. The charge transferred from stage to stage in one cycle is $C(V_2-V_1)$ and the average short-circuit current is therefore $C(V_2-V_1)/T$. By inspection of Fig. 4:

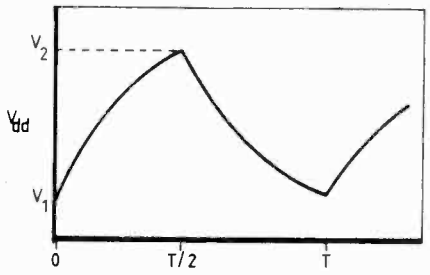

Fig. 4. The waveform seen at point X or Y of Fig 2 when R is not negligible.

$$V_1 = V_2 e^{-T/NRC}$$
$$V_2 = V_{dd} - V_1$$
$$\text{Hence } V_2 - V_1 = V_{dd}(1-e^{-T/NRC})/(i+e^{-T/NRC}) = V_{dd}\tanh(T/2NRC)$$

With ideal diodes the open-circuit output voltage is NV_{dd} and so the output resistance is given by

$$NV_{dd}T/C(V_2-V_1) = (NT/C)\coth(T/2NRC).$$

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Digital filter design procedure — 3

Despite its limitations a high-pass digital filter is easily designed by 'inverting' its equivalent low-pass version (July issue). Except for sign changes, pole and zero parameters are the same.

Previous articles with this title were in the May and July 1983 issues, the first outlining how to design the digital equivalent of an analogue filter where the transfer function can be simply formulated. As an example, the article derived in detail the digital equivalent of a parallel tuned circuit, and one case had pole positions chosen with a simple microprocessor in mind. The second article covered the case where the z-plane transfer function had to be derived from an analogue filter using a bilinear transformation, and a fourth-order low-pass Butterworth filter was used as an example.

by J. T. R. Sylvester-Bradley M.A.

One can argue that even in the analogue world a high-pass filter cannot really exist as it is not possible for a circuit to pass signals of an infinite frequency. The Butterworth low-pass filter has a flat response from zero up to its cut-off, but the flat response of the equivalent high-pass filter cannot possibly extend from cut-off to infinity. However, as explained in the previous article, with the digital version of the Butterworth low-pass filter, the digital equivalent to an infinite frequency is the maximum frequency that the digital filter can handle, that is half the sampling frequency.

The same applies to the high-pass digital filter, and within this limitation it can have a flat response from its cut-off frequency up to the digital equivalent of an infinite frequency (f_{max}), see Fig. 1, where the spectra (or more precisely, the Fourier transforms of the impulse responses) of both low-pass and high-pass ideal analogue filters are compared with their digital equivalents. In the last mentioned the spectra are repeated at multiples (harmonics) of the sampling frequency.

Once the limitations of the high-pass filter are recognized, a filter which is the precise equivalent to its low-pass version is easily designed by inverting the position of the low-pass poles and zeros on the Z plane.

Figure 2 shows the spectrum and Z-plane diagram of the high-pass filter designed in this way to be an exact equivalent of the low-pass filter designed in the previous article (Fig. 10 of that article).

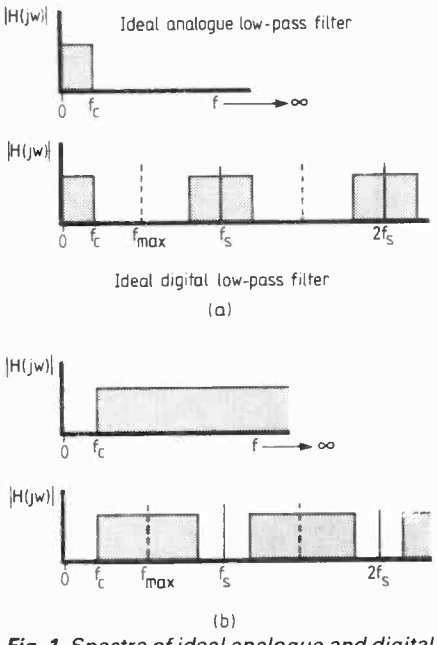


Fig. 1. Spectra of ideal analogue and digital low-pass filters compare as at top diagram (a), while ideal analogue and digital high-pass filters compare at bottom (b). Frequency f_{max} is the digital equivalent to an infinite analogue frequency.

Pole and zero positions

The pole positions for the low-pass filter were

pole 1 $r_1/\omega_1 T = 0.758\angle 137.2°$
pole 2 $r_2/\omega_2 T = 0.458\angle 159.1°$,

with poles 3 & 4 as their conjugates. The four zeros were all located at $1.0\angle 180°$.

The pole and zero positions for the high-pass filter are found by adding 180° to the above positions, giving

pole 1 $r_1/\omega_1 T = 0.758\angle 42.8°$
pole 2 $r_2/\omega_2 T = 0.458\angle 20.9°$,

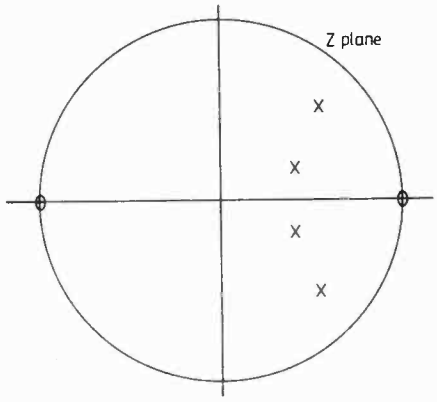
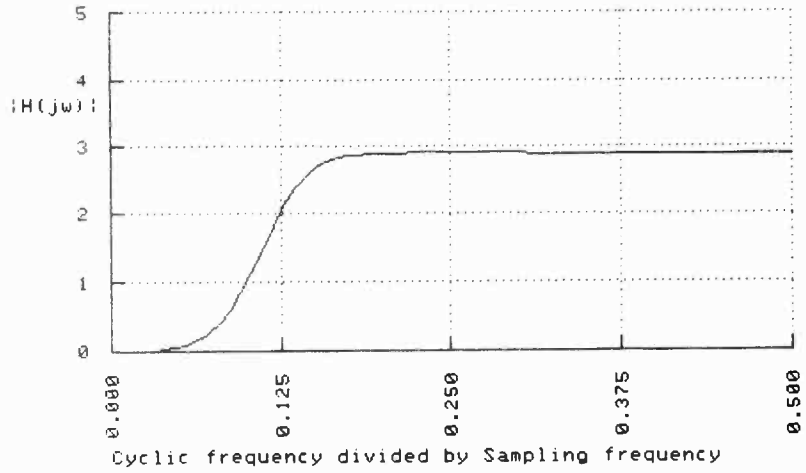


Fig. 2. Spectrum and Z-plane diagram and |H(jω)| of digital equivalent of high-pass Butterworth filter.



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with poles 3 & 4 as their conjugates, and with the four zeros located at $1.0\angle 0°$.

The spectrum of Fig. 2 shows a flat response from just above the cut-off frequency (f_c) up to f_{max} and

$$f_c = \tfrac{1}{8}f_s = \tfrac{1}{4}f_{max}.$$

Transfer function

For the high-pass filter $H(z) =$

$$\frac{(z-1)^4}{(z-r_1e^{j\omega_1T})(z-r_1e^{-j\omega_1T})(z-r_2e^{j\omega_2T})(z-r_2e^{-j\omega_2T})} \qquad (1)$$

multiply the denominator to evaluate the pole parameters:

$$(z^2-2zr_1\cos\omega_1T+r_1^2)(z^2-2zr_2\cos\omega_2T+r_2^2)$$
$$=z^4-2z^3r_1\cos\omega_1T+z^2r_1^2-2z^3r_2\cos\omega_2T+$$
$$4z^2r_1r_2\cos\omega_1T\cos\omega_2T-2zr_1^2r_2\cos\omega_2T+$$
$$z^2r_2^2-2zr_1r_2^2\cos\omega_1T+r_1^2r_2^2.$$

Collect like terms:

z^4	z^3	z^2	z^1	z^0
1	$-2r_1\cos\omega_1T$	r_1^2		
	$-2r_2\cos\omega_2T$	$4r_1r_2\cos\omega_1T\cos\omega_2T$		
			$-2r_1^2r_2\cos\omega_2T$	
		r_2^2	$-2r_1r_2^2\cos\omega_1T$	$r_1^2r_2^2$

From the pole positions,

$r_1 = 0.758$
$\omega_1T = 42.8°$ $\cos\omega_1T = 0.7337$

$r_2 = 0.458$
$\omega_2T = 20.9°$ $\cos\omega_2T = 0.9342$.

Therefore the pole parameters are

z^4	z^3	z^2	z	z^0
a_0	a_1	a_2	a_3	a_4
1	−1.1123	0.5746		
	−0.8557	0.9518	−0.4917	
		0.2098	−0.2333	0.1205
Σ1	−1.968	1.7362	−0.725	0.1205

The pole parameters, a_n ($n=0$ to 4) for the high-pass filter above are the same, except for sign changes, as for the low-pass filter designed in the previous article. Some paperwork would therefore be avoidable if the high-pass filter is designed as the inverse of low-pass filter already designed.

The transfer function can now be written to include the pole parameters, and assuming unity gain, $H(z) =$

$$\frac{(z-1)^4}{z^4-1.968z^3+1.736z^2-0.725z+0.1205} = \frac{Y(z)}{X(z)} \qquad (2)$$

In the numerator the zero parameters b_0 to b_4 can be found by expanding $(z-1)^4$ (or from Pascal's triangle):

$$(z-1)^4 = z^4-4z^3+6z^2-4z+1.$$

Values for b_n are the same as for the low-pass filter, except for sign changes in b_1

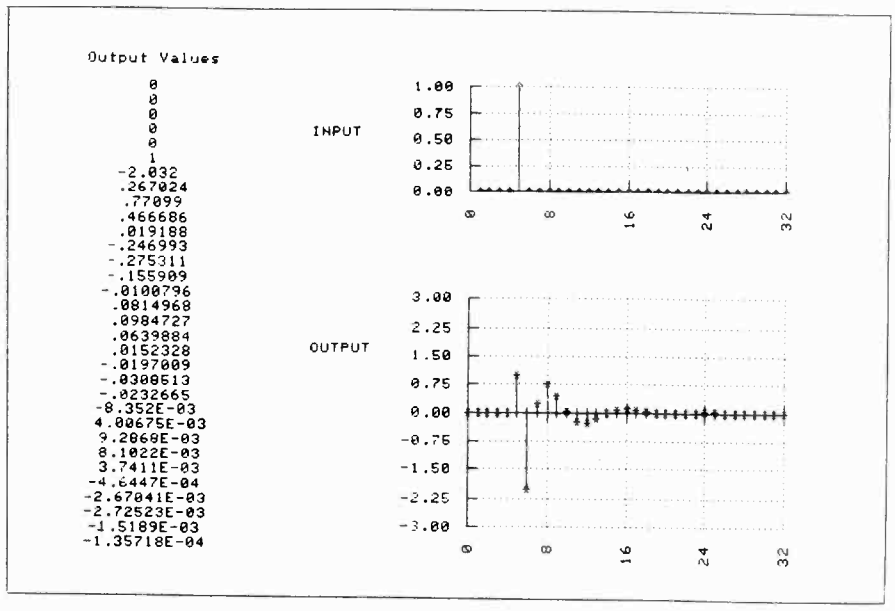
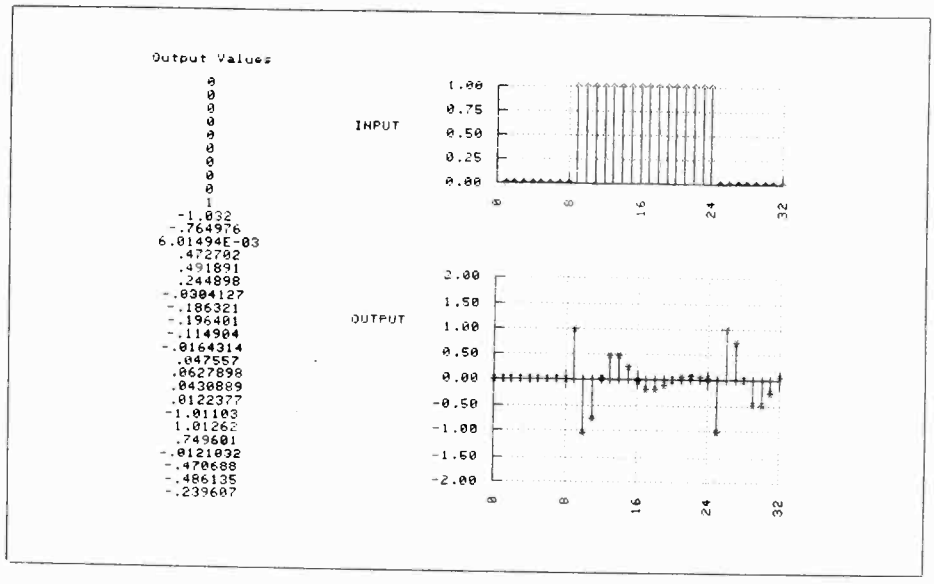
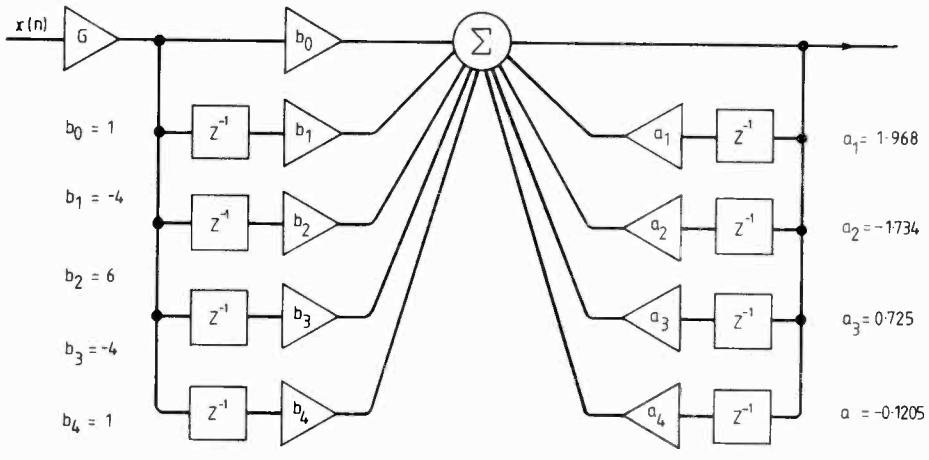


Fig. 4. Impulse response of high-pass digital filter showing "ringing" at $\frac{1}{8}f_s$ (top).

Fig. 5. Output of high-pass digital filter with a long (16 samples) input pulse (below).

Fig. 3. Realization diagram for the 4th-order Butterworth high-pass digital filter (bottom).





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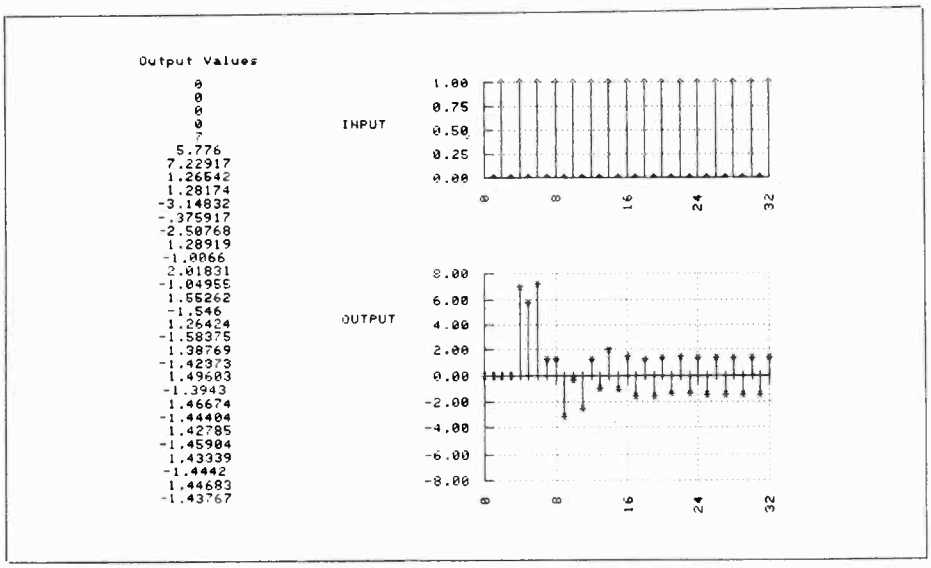


***Fig. 6.** After the switching transient, pulses are transmitted but with no d.c. component. Input is at f_{max}.*

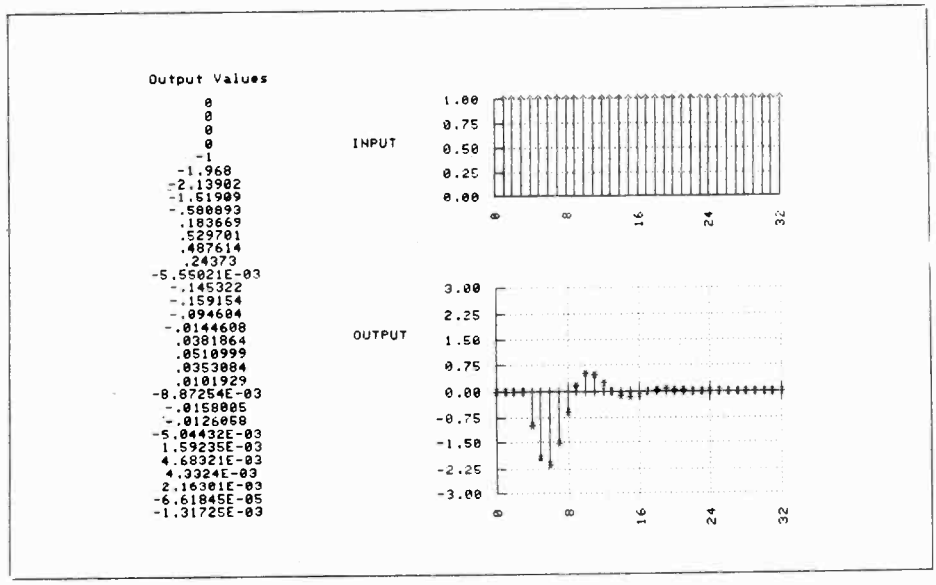
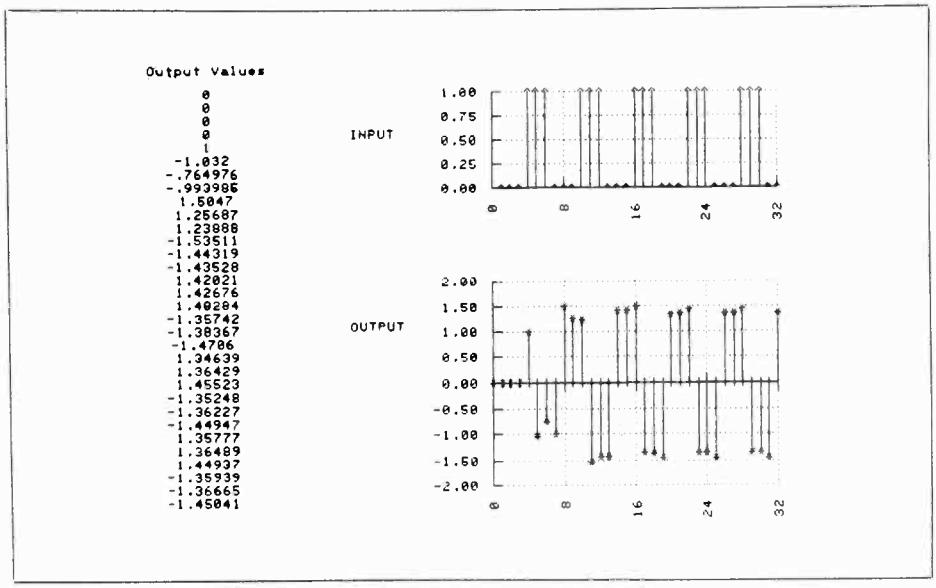


***Fig. 7.** In spite of being a "high-pass" filter, it cannot pass frequencies above f_{max}. Here the input is zero (after switching transient) with an input at the sampling frequency.*

***Fig. 8.** Pulse train within the passband of the filter passed without distortion but with no d.c. component.*



and b_3. Cross multiplying in the equation for H(z) and dividing by z^4 gives the expression for Y(z):

$$Y(z)=1.968Y(z)z^{-1}-1.734Y(z)z^{-2}+0.725Y(z)z^{-3}+0.1205Y(z)z^{-4}+X(z)-4X(z)z^{-1}+6X(z)z^{-2}-4X(z)z^{-3}+z^{-4}.$$

The recurrence formula is therefore

$$y(n)=1.968y(n-1)-1.734y(n-2)+0.725y(n-3)-0.1205y(n-4)+x(n)-4x(n-1)+6x(n-2)-4x(n-3)+x(n-4)$$

which can be written directly into a computer program to realize the filter. The realization diagram and impulse response are shown in Figs 3 and 4.

The output with a long rectangular input pulse, as in Fig. 5, clearly shows the differentiating effect of the filter, together with some ringing at the cut-off frequency.

With an input at f_{max}, (in Fig. 6 the on/off pulses are at half the sampling frequency) the output soon settles down to passing the pulses, but with their d.c. component removed. The output settles down after the ringing effect of the switching transient is over.

The filter is unable to pass a frequency equal to f_s, Fig. 7.

With a series of rectangular pulses three samples long their frequencies are well within the pass-band of the filter, and at Fig. 8 the pulse train is passed without much distortion (after the switching transient) but with the d.c. component removed.

In the July 1983 article, a slip occured on page 43, in which X(z) was inadvertently repeated in the penultimate line.

If you read that article you will no doubt have spotted that the last two lines of text in column one on page 44 should have followed the recurrence formula. – dep. ed.

Who was Fessenden?

When J. D. Parker received the Fessenden Award from the National Marine Electronic Association, he had to confess that he did not know of Fessenden. So the NMEA provided him with an article from the January 1930 issue of *Radio-Craft*. Reginald A. Fessenden, it turned out, worked with Edison as an electrical engineer and as chief chemist. He later became professor of electrical engineering at Western University, Pittsburg and as early as 1895 began experimental work with radio waves. Through his knowledge of sound waves he conceived the idea of modulating a continuously oscillating radio wave and his was the first voice ever to be heard on radio. He invented the rectifying electrolytic detector, the successor to the coherer, and his other inventions included the r.f. alternator and the rotary spark-gap. He suggested the principle of heterodyning but was unable to go further until the development of suitable ocillator valves. He also spent a considerable time working on navigation and signalling at sea.

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NEWS

DSP, the next big step

Digital signal processing does the same things that are familiar to computer users. It executes algorithms. However in most computer applications relatively small batches of data are processed and they often do not require immediate processing. Many are familiar with the 'printout will be available next Tuesday' system. D.s.p. offers the ability to process great volumes of data with no observable delay, in 'real time'.

The technique is not particularly new. It has been used in specialized military and aerospace programmes where ultra-fast real-time computation is said to be needed, and used very expensive array processors. What is new is the production of integrated circuits that make it feasible to perform tasks previously too expensive for general use or only possible on analogue equipment.

An example of the use of d.s.p. is spectrum analysis of the vibrations in an engine on test. A. d.s.p. spectrum analyser receives signals from transducers attached to the engine. It converts the analogue signals to digital signals, processed through filters to analyse the frequency content of the vibrations and provide an instant printout or display on the current state-of-health of the engine. Such equipment might now be the size of a personal computer but the new integrated circuits will reduce this to a handful of chips. A car, for example, might be fitted with a self-diagnosed module and a collision-avoidance system. Similarly small packages could be used for speech analysis, speech synthesis or for helping to compensate for hearing, speech or sight impairments.

All d.s.p. algorithms have similar structures. They typically require the multiplication and totalling of strings of numbers. This structure is similar to the totalling of a bill where data (e.g. quantities) and coefficients (e.g. prices) are multiplied together to give subtotals which are, in turn, all added to give a grand total. Such multiplication of data and coefficients is known as array processing. Typical algorithms are digital filtering, which may be used for improving the signal-to-noise ratio; spectral analysis, which uses fast Fourier transforms to determine the frequency content of a signal; correlation, to compare signals; estimation, to decide on the validity of a signal that is incomplete or obscured by noise; and control.

A typical d.s.p. multiplier can complete a multiplication in 150ns, about 1000 times faster than a standard microprocessor. Multipliers are typical building blocks for d.s.p. hardware, others are arithmetic logic units and sequencers.

Belying their name, Analog Devices have launched a 16 by 16-bit multiplier accumulator (mac), the ADSP-1110. This c.mos device provides a 40-bit internal accumulator and yet fits onto a standard 28-pin dual in-line package. This is because it uses only a single port but operating from a 10MHz clock, the mac can alternately load x and y operands and, when instructed, output the result.

The mac can be used as a low-cost computational accelerator in graphics systems where matrix multiplications are used in image manipulation to translate, rotate or zoom the image. Under control of the system's processor, the mac can multiply a four-by-four matrix and a four-by-one vector, requiring 16 operations in less than 4μs. It operates on six-bit instruction words, there are two control lines and an overflow flag. In the event of an overflow there is an eight-bit accumulator overflow register. The ceramic version of the ADSP-1110 is available in sample quantities. It can operate over the temperature range −55 to 125°C. A plastics-housed version with a more modest temperature range, 0 to 75°C will be available soon. Prices are thought to be about £75 each if bought in quantities over 100. Analog Devices Ltd, East Molesey, Surrey KT8 0SN.

Electronic potato

If you have noticed that the potatoes you buy are less battered than before, this may be due to research carried out by the Scottish Institute for Agricultural Engineering (SIAE). They developed an electronic potato made out of plastic foam enclosing an Entran accelerometer, a transmitter and small rechargeable batteries. The transmitter sends out a v.h.f. radio signal, modulated when the transducer is activated. This potato is handled during harvesting and pototo grading along with a batch of real potatoes and the stages when the is at most risk from damage can be monitored. A battery operated receiver and tape recorder are used to record the signals transmitted from the potato and 'voice-over' commentary may be recorded at the same time to identify the stages actually taking place. Machine adjustments, modifications or alterations to the operating speed can all be assessed with the electronic spud. Moreover it can also disguise itself as an apple or an onion which are also subject to mechanical handling. A similar technique has been used to monitor raspberry harvesting with electronic raspberries.

Do you remember Baird tv?

If you do, the Royal Television Society would like to get in touch with you. They are planning an event to mark the 50 years that have passed since the 30-line service was terminated. They would like to identify as many of those 'pioneer viewers' as possible. The honorary secretary of the midland centre of the RTS is John Grantham, at BBC Network Production Centre, Pebble Mill Road, Birmingham, B5 7QQ.

Briton honoured

The tenth Marconi International Fellowship has been awarded to Professor Eric Ash. Dr Ash, Professor of Electronics at University College, London, has been made "in recognition of his outstanding leadership and pioneering work in the emerging technologies of acoustic surface wave device, optical fibre-based communications, acoustic optics and acoustic imaging".

Marconi International Fellowships were founded by Guglielmo Marconi's family and are awarded each year to further research by "a leading world scientist who has made a distinguished contribution to those areas of science and technology that improve the quality of life". Readers may recall that in 1982 the fellowship was awarded to Dr Arthur C. Clarke for first specifying the potentialities and technical requirements for the use of synchronous orbiting satellites for global communications.

High-Com stereo radio

A three month public trial of compressed f.m. broadcasts is under way in Federal Germany. The system had to offer no reduction in quality to the listener without an expander in the receiver and yet when an expander fitted there should be a noticeable difference. Not surprisingly, ARD chose a home-grown product – AEG-Telefunken's High-Com compander system. The system had to be modified to fit the requirements (see German radio show report, November 1983, page 75). After modification only two out of 13 'guinea pigs' could tell any difference between the compressed and uncompressed signal and then only in direct comparisons. Moreover, tests in cars showed that there was an audible improvement in v.h.f. reception of the compressed but unexpanded signals. It is thought that this was because the compressed signal increased the volume of quieter passages which were then more easily heard above the noise background.

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Interface to be made in bulk

Swamped by the orders for the IEEE488 Procyon interface for the Acorn/BBC microcomputer, Cambridge Systems Technology have been forced to award an assembly contract for the unit to an outside manufacturer. The contract has gone to CVO Electronics of Stevenage.

The device has found a considerable number of customers in professional, scientific and educational users. A high proportion of scientific test instruments use 488 interfacing especially from such manufacturers as Hewlett Packard, CBM, Philips, and Tektronix, and therefore can be monitored or controlled through a BBC computer fitted with the Procyon unit.

TAT-8 *will* be optical

International agreement between 28 telecommunications authorities has given the go-ahead for TAT-8, which will use hair-thin glass fibres. Two pairs of fibres will be incorporated in the cable. Each pair will operate digitally at 280Mbit/s to give a total capacity of 8000 telephone circuits. This basic capacity can be increased by digital circuit multiplying equipment up to 40 000, although initially only a small proportion of this potential capacity will be used. Monomode transmission will give the cable this high capacity and allow a long spacing, 30 to 55km, between light regenerators, the equivalent of repeaters on wire cables which are needed every 5km.

The American end of the cable will start at Tuckerton, New Jersey and the main part, 5 800km will be provided by AT&T Communications. Near the European continental shelf, a junction box will allow the cable to be split two ways. 520km of cable will be laid by STC to join the junction box to Widemouth Bay, Cornwall, while another 310km will branch off to Penmarche on the Brittany coast of France. The French branch will be the responsibility of a French company, Submarcom.

Cables and satellites share about half each the total capacity of telecommunications across the ocean. At present, including TAT-7, the cable capacity is about 11 200 telephone circuits. TAT-8, expected to come into operation in 1988, will more than double this.

Home energy monitor

On page 36 of this issue is a project to build a differential temperature integrator to monitor temperature differences in a house. Designed by Bob Everett, a research fellow at the Open University, and engineered by the OU Electronics Common Facility, 100 of them were made and installed in houses in Milton Keynes in the summer of 1981 as part of a series of energy conservation field trials. The Building Research Establishment put the device on its list of equipment suitable for such monitoring.

The device has proved to be useful and reliable and the OU has had a continuous stream of letters from architects and research students who would like to borrow one or have the circuit. But the potential for making them commercially is small: "The design will surely be superseded within a year or so by a suitable c.mos processor," says Bob Everett. The current cost of the components for the integrator excluding the p.c.b. and the box is a little over £100, whereas current competitive commercial systems is mainly restricted to microprocessor systems for ten or single channel ram-based devices at £400. "Although the world is full of well-intentioned people who would like to monitor the energy performance of their houses," says Everett, "there are few who are prepared to fork out that much money or harness the i/o port of their home computers to temperature monitoring for six months solid.

"It would be nice if it were possible to get the integrator as a kit," he commented, "the Open University would have no problems in selling the two double-sided circuit boards required, and the whole thing would have the blessing of the Department of Energy, though it could be of more interest to countries such as Denmark and France where energy conservation research is not quite as unfashionable as it is here."

Amongst the facilities at the Daresbury Laboratory of the Science and Engineering Research Council are the world's largest tandem Van der Graaff accelerator and the world's first high energy electron accelerator dedicated to the production and use of synchroton radiation. In experiments to study the details of atomic nuclei, ions are accelerated to energy levels up to 20MeV. Synchrotron radiation is emitted when electron have been accelerated to a peak level of 2GeV and then deflected by the fields of storage ring magnets. It is used in atomic and molecular spectroscopy, X-ray spectroscopy and surface science. Microprocessor monitoring and alarm systems are provided by Sattcontrol of Aldershot.

In brief

Giotto, the space probe which is to intercept Halley's Comet in 1986, has undergone a comprehensive check-out on its electrical and electromagnetic characteristics. The tests, on this European Space Agency project, have been carried out by British Aerospace Dynamics group, Bristol. The circular test chamber is 14m in diameter and 12m high, where the vehicle has been subjected to r.f. tests from 0.1Hz to 18GHz.

The formation of a new computer company and a new computer has been announced. The first product of Compass Computers, of Tetbury, Gloucestershire, will be the Compass 32. This is a multi-user computer which will run CP/M, MS-Dos, or Unix under the DEC operating systems. Each user will have a Z80 or an 8088 processor and 64KBytes of ram. Winchester disc memory will be available. The company is also planning a variety of add-on devices for the DEC range of computers which will include communications boards, mass storage systems, etc.

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LETTERS

AMATEUR BAND JAMMING

Under the heading "Moral persuasion" (Communications Commentary, August issue) the claim is made that China has ceased to operate broadcast stations in the 7000 to 7100kHz amateur band. Whilst it may well be true that Chinese broadcast stations in this band are not heard in Europe, it is completely incorrect to say that these stations have quit the so-called amateur-exclusive band at 7000-7100kHz.

As coordinator of the New Zealand Intruder Watch, and as coordinator for the Region 3 IARU Monitoring Service, I daily handle many complaints from amateurs regarding the use of this band by the Chinese broadcasting services – and others! My records for September and October show the following frequencies to be in current usage by the Chinese Service: 7010, 7025, 7030, 7035, 7040, 7045, 7050, 7055 and 7095kHz.

With reference to the 7010kHz frequency it appears that some rearrangement of schedules may have been made but the frequency is still used by China. The People's Liberation Army station on the nominal frequency of 7025kHz, and the regular Radio Beijing station on 7055kHz, hop around between the above noted frequencies depending on the degree of jamming they are being subjected to by the Russians.

The "hopping" from one frequency to another, without warning and often in the middle of an item, brings into question – at least in my mind – the value, if any, of this type of broadcasting.

Resolution 641 of WARC 1979 calls upon stations using this band to vacate it. To date this resolution has been ignored by China – using the "reservations" procedure of the ITU Convention, and simply ignored by Albania with its Radio Tirana on 7065, 7075 & 7090kHz.

Albania at least does have the excuse that it is not a signatory to the ITU Convention, not so China and the USSR, although we "down under" do wish somebody "up there" would show the Albanians how to operate their transmitters without the resultant daily high level 2nd harmonics on 20 metres.

The USSR at times re-broadcasts one of its Mayac (home service) programmes on top of Radio Beijing – grossly over modulated – as a jamming technique, and has the lower sideband of its 7100kHz transmissions in the amateur band. To say nothing of the intense jamming, with 2nd and 3rd harmonics appearing on other amateur bands.

The "footnoting" into the 7000-7050kHz portion of this band by the fixed services of 13 countries plus its unauthorized use by the Russian fixed service, and the broadcast service as noted above, brings into mockery the whole concept of an "exclusive" band for the amateur service.

A recent random check of this band by the WIA Intruder Watch, and later confirmed by the NZART Intruder Watch, showed that between the hours of 1900 to 1925 u.t.c. on the 13th July 1983 there were 11 broadcast stations present in this band plus seven jammers, and that the activities of these stations accounted for 70.7% of the available 100kHz. At this date (28-11-83) the situation has not changed appreciably!

We can only hope that the 1984 WARC for h.f. broadcasters will go some way to alleviate the current situation on this band.

R. E. Knowles, ZL1BAD/ZL61W
Coordinator NZART Intruder Watch
Tuakau
New Zealand

RADIO SOFTWARE

With regard to your picture coverage of our Computer Programme, Datarama, and the subsequent reponse from our colleagues at BBC Radio Leeds claiming that they were the true pioneers of Radiosoftware, I should like to make a few salient points.

Firstly, we are not in the business of claiming firsts: we believe the true originators of Radiosoftware as a broadcasting fact to be The Dutch Hobby Scoop Programme,* which began doing it in 1978.

Secondly the Datarama team, unlike it would seem the BBC Leeds team and others who've followed suit, conducted its own 'experimental data transmissions' under controlled conditions and out of broadcasting hours, i.e. not during programme time. When the first series of Datarama went on air in March 1983, Radiosoftware, at least in our hands had passed beyond the stage of experiment and was a properly researched piece of broadcast material. Within the current series, Radiosoftware forms as natural a part of the programme, as does conversation. There is no more experimentation necessary. It is time to get on with it.

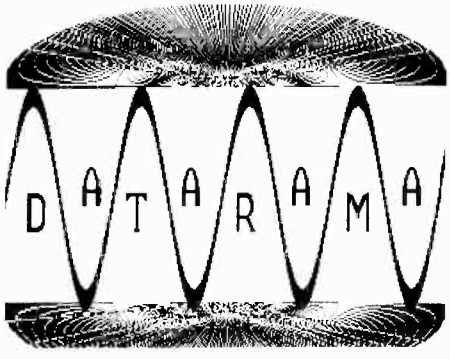
Thirdly, in conjunction with the IBA , we have produced outline specifications which we hope will form the basis of future technical specifications for any station wishing to broadcast Radiosoftware. These should be available from local IBA officers in all regions.

Datarama is broadcast weekly on Radio West (in the Avon area), and on Wiltshire Radio (Swindon/W. Wilts) and very shortly on CBC Radio (Cardiff). Since its inception, each programme has included Radiosoftware for at least one microcomputer.

On the RW transmission, Datarama is supplemented by longer programmes for more micros transmitted after the stations closedown. These 'Nightfile' tapes are repeated at ¼ hour intervals throughout the night, a technique copied by Barry Norman's excellent 'Chip shop take-away service,' except that ours are free, and theirs require you to spend £3.95 on a translator kit, which is still not available at the time of writing!

Tim Lyons
Chief Engineer
Radio West
Bristol

*See also News, November, 1982.



ENERGY SAVING

I read Mr MacHarg's article and the subsequent correspondence with interest. Several of my colleagues have an interest in optimizing heating systems, and many lunch-time conversations have taken place, during which useful exchanges of ideas occur. Many different ideas are aired; individuals rate different aspects of a system with varied importance. To my mind it is necessary to get back to basics if we are to make decisions which enable us to optimize a system.

The object of a heating system is to burn fuel, thereby warming the house. A stable situation exists when heat input equals heat loss. Therefore the better insulated the property, the less energy we have to put in. This may seem very obvious, but is the first step.

Assuming, for the moment, that boiler efficiency is not affected by flame height, then in theory we could adjust the flame height to provide water at a constant temperature, so that the heat lost by the radiators was equal to the heat lost by the house to the outside world.

The usual type of system does not work this way; we rely on a variable burner duty cycle followed by the integrating effect of large thermal masses to iron out the discontinuity. Having said this we next need to define the areas of waste. There is the basic loss of heat from the building, and there is heat loss up the boiler flue. If the boiler was 100% efficient, all the heat would go into the house. Because of the effects of integration, the temperature will rise before a control thermostat operates, but continue to do so afterwards. It is recognised that the thermal inertia is normally too great to allow a simple thermostat to be used, which is why the "accelerator" heating resistor is fitted into the majority of room thermostats.

Taken in isolation, this arrangement, if operating in a constant temperature, is a duty-cycle control device. By allowing a passage of air through this device the duty cycle is modified by ambient temperature as well as by manipulation of the control. Provided that the rate of heating by the accelerator resistor can be adjusted to suit the thermal inertia of the system, a simple means of optimization is available. Unfortunately, most proprietary items do not have such a facility, so a basically sound principle is nearly always subject to maladjustment in a particular installation.

I believe that it is undesirable to have a boiler cycle continuously, particularly when only the pump is controlled by a thermostat. Unfortunately Mr Ball, whose system employs a room thermostat to control both pump and boiler simultaneously, seems to have received short shrift from Mr MacHarg in the correspondence column. This is probably because Mr Ball has not gone into as much analysis of his simple system as is desirable. I have used a similar, but not identical, system for several years. The system operates successfully because not only does it avoid excessive cycling of the boiler, but also keeps the boiler temperature as low as possible consistent with providing adequate heat, as advocated by Mr Hargis. The less required, the shorter the duty cycle becomes (controlled by the thermostat with accelerator resistor) and consequently, the lower is the maximum water temperature attained throughout the cycle. Therefore the heating effect on the surrounding air is a function of both time and rising water temperature – a point which did not emerge in Mr Ball's letter.

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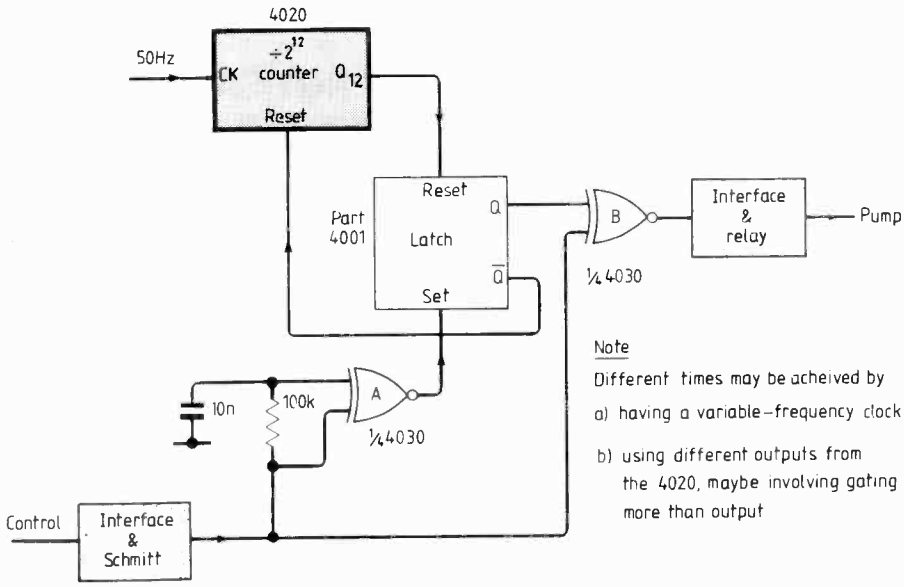


The colder the weather, the greater the heat loss from the house, the longer will be the thermostat (and therefore, boiler) on duty cycle and the hotter the radiators become. To my mind, this is exactly what a sensible system should do. It is only under the most adverse conditions that I have known the boiler thermostat (set to 77°C) to operate. The system works well because I have taken care to "tune" the accelerator resistor as mentioned earlier, using a modified commercial thermostat, placed in a carefully chosen position.

Economies *can* be made by modifying simple systems as described. First, I have delayed the pump start and stop relative to the controlled boiler cycle. The boiler has a cast-iron heat exchanger, and a pump delay of about 82 seconds enables the boiler temperature to rise quickly, but without overshoot, after ignition and also enables a substantial amount of heat to be extracted from the iron after the flame is extinguished.

Another economy is made by designing the domestic hot water heating facility to latch up, so it is not defeated by the clock. This enables the water heating cycle to be completed before the boiler is turned off. The facility is particularly helpful in summer, when it prevents the need for re-ignition of the boiler at the start of the following day.

I should also point out that I heat the whole house consistently; radiator valves have been adjusted and are never normally touched. Furthermore I use no supplementary heating; this would upset the balance of the system. If supplementary heating is to be used, the subject of control becomes more complex and thermostatic radiator valves are likely to be needed. This would result in changes of heat output in other areas if the duty-cycle system I have described is used.

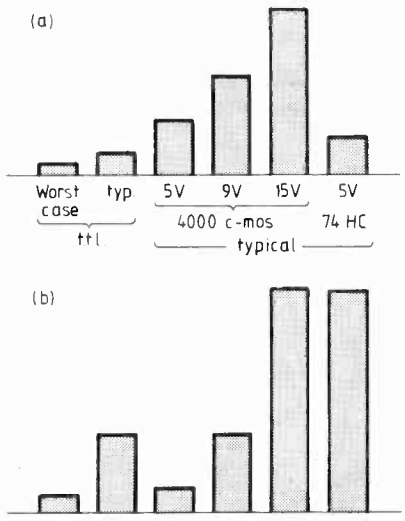
Finally, I believe long electrical time constants to be a potential problem because of the large values of resistance and capacitance needed. The diagram shows the bare bones of the 82 second delay referred to earlier. A $\div 2^{12}$ counter counts 50Hz mains pulses, but is normally held in the reset condition. The "go" control signal (which has also fired the boiler) causes the output from the interface and Schmitt to go high. A high or low excursion on this line results in a pulse emerging from 4030A, which sets the latch. Output goes high, maintaining a low at the output of B. Output Q goes low and removes the reset from the counter, which then counts $2^{12} = 4096$ pulses at 50 per second; this takes 81.92 seconds. The output from Q12? goes high and resets the latch; B now has only one high on its inputs – its output goes high and the pump starts. Conversely, when the control input goes low, the counter is started again which sets Q high. As the other input to 4030B is now low, the pump keeps running until the circuit times out.

Keith Cummins
Southampton
Hampshire

LOGIC NOISE MARGINS

It is standard practice to talk of noise margins in terms of noise voltage. The meaning of this is, to say the least, vague, although it has its uses. For instance t.t.l. is quoted as having a noise margin of 0.9 volts, so it is obviously asking for trouble to use discrete diodes to expand the fan in, a reasonably common malpractice, because it reduces the margin to 0.2 volts.

The c-mos 4000 series is quoted as having a noise margin of 45% of the supply voltage – clearly superior as compared with t.t.l. – but this is only half the story. When signal lines are short as is desirable and likely within a piece of equipment, they take their impedence from the driving output according to the slogan "Low Z rules, OK?"



Short lines driven by t.t.l. are at an impedance of about 100 and the noise *power* necessary to overcome the noise voltage margin is $V^2/R = 0.9^2/100$ or about 8mW. The output resistance of 4000 series c-mos is 1.5kΩ to 2kΩ, so with a supply voltage of 5V the power needed to raise (or lower) the potential on the line by 45% is $2.25^2/2000 \approx 2.5$mW. The noise power margin of t.t.l. is over three times as great at this supply voltage, see diagram.

It is worth noting that 54HC and 74HC logic has a much lower output resistance and a noise voltage margain of about 1.5 volts. Taking output resistance as 100Ω – it is in that parish though I have not seen it quoted – this requires a noise power of $1.5^2/100 = 22.5$mW to overcome the noise voltage margin.

Using the same noise power concept, 4000 series c-mos requires a supply voltage of 9 volts to match the t.t.l. margain of 8mW, and only at a supply voltage of 15V does it achieve a noise power margin of 23mW, the equal in this respect of 74HCXX.

So far I have been considering short lines which take their impedance from the driving output. Long lines are a different matter. Correct termination is vital to establish the designed (low) impedance of the line and therefore confirm the designed noise power margin of the receiver device. It also performs its well known task of minimising reflection and radiation, two most potent causes of noise and crosstalk. Once again we are specifying and maximizing the noise power margin.

Our evalution is not yet quite complete. An additional factor to be taken into account is the frequency response of the logic. 4000 c-mos just does not have time to propagate a noise spike of width 10ns, so its tardiness has considerable advantage if the system can be run at a frequency suitable to this logic family. The noise is effectively band limited and this is where 4000 c-mos really scores in noise immunity. The old 4049 buffer was particularly good in this respect, having a frequency limit of about 180kHz. Updated versions have a propagation delay of 60ns. Modern fast logic has a much greater bandwidth and is therefore vulnerable also to high frequency noise. So we are concerned with a balance of two factors; the noise power margin and the noise power bandwidth, both here defined by the characteristics of the logic. It is desirable to arrive at a figure of merit for noise immunity, taking both factors into account and expressed in terms which are, ideally, self-explanatory. I would welcome comments on the subject.

Tim Hartigan
Ballsbridge
Dublin

FORTH PROCESSORS

In his article and letter in November Wireless World Mr Woodroffe is less scrupulous than the Intel benchmark report that he obliquely criticises. This report, which compares the 68B09 with the 8088, can only really be faulted on the grounds that no allowance is made for code frequency in averaging out relative execution times and code sizes. It indicates, quite correctly, that re-entrancy is handled faster by the 6809.

By contrast, the table presented in his article by Mr Woodroffe can be faulted on several grounds. First, it omits the Texas 9995 processor, which competes in the same market sector as the 6809 (64k address, nonsegmented). I wonder why? The 9995 has a non-multiplexed bus and fast 16-bit parallel onboard ram; for 450ns access time its bus cycle is 670ns, versus

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800 for the 8088 and 1000 for the 6809. It also makes use of prefetch.

Second, and more serious, some funny arithmetic occurs before the bottom line. The relative speeds for the 6809 and the 8088 are given as 4.11 and 3.19 respectively although the 8088 actually executes its code faster. This is derived from this "speed for 450 nanosecond access memory." I have news for Mr Woodroffe; in the real world it is not desirable to run a processor with a bus cycle allowing 695ns access at a speed which gives 450ns access. It tends not to work. In the real world the 8088 is faster by nearly 30%. Of course it would be perfectly practical to use a faster 6809 – the 68A or B 09 options – but then he should say so. If he is not actually using these faster devices in his own computer, he should tell us what access time his hardware actually requires, and recalculate his last line on that basis.

The third objection, however, is that in reality the 8088 programmer is unlikely to use the "JMP NEXT", as this requires that NEXT be within 127 bytes, necessitating numerous NEXTs scattered throughout the code rather like Underground stations (I nearly wrote public conveniences) in London. He or she will accept the 9-byte inline code (typical 6809 code is twice as long as typical 8088 code), losing 15 clocks and giving 8.6 microseconds. This execution time is slightly less than for the 6809 running at 1.5MHz with a comparable memory access time. The point, surely, is that the 8088 is the more expensive device, and the time and effort required to use features like segmentation mean that they are likely to be wasted in a small domestic microcomputer. There is no point in buying unused silicon.

The comments about code usage I agree with, except as regards the very arbitrary 80/20 ratio, seen quoted elsewhere as 75/25, ⅓/⅔ – it is true that in most high level languages most of the time is spent pushing garbage to keep the system happy. This is why high level languages waste silicon and time while keeping programmers employed. However, the picture can change dramatically as soon as real arithmetic starts to happen, especially when trigonometry is involved. The makers of home computers assume, generally correctly, that most users will never stretch the resources of the mathematics. I would have thought, however, that electronic engineers differed in this respect; in the days when I was limited to a programmable calculator I remember calculations that exercised the poor little thing for hours on end, leading me to wish a bleeper had been fitted to announce the result. For this reason I would have thought that, again, the TMS9995 would have been a strong contender for a CPU because of its ability to handle 16 bit signed and unsigned multiplication and division in the instruction set.

Perhaps I should add that I am in no way connected with any semiconductor manufacturer.

Martin D. Bacon
Taunton
Somerset

WORLD TIMING

I am pleased that Dr J. D. H. Pilkington, head of the time department at Royal Greenwich Observatory, provided better background to the subject of "World Timing" than we were authorized to in our article on the subject; *WW* October 1983.

In our laboratory we make use of the special transmissions which disseminate UTC and CAT (co-ordinated atomic time) for calibrating and monitoring frequency sources and transmissions. Therefore, one of the purposes of our article was to draw attention to the less tightly co-ordinated h.f. broadcast (and m.f.) frequencies by broadcasters since as we said, "errors of frequency can in fact be more of a nuisance than an error of time".

Indeed, in an European Broadcasting Union Report (SBP66) entitled "A study of technical questions of interest to the WARC 1979", it was pointed out (paragraph 1.4) that the then frequency tolerance of l.f./m.f. and h.f. transmitters was unnecessarily generous, and that the stability of all carriers should be within 1Hz of the nominal assigned frequency by 31 December, 1984. It would appear from Dr Pilkington's letter that some broadcast authorities could have a busy year.

R. C. V. Macario
Department of Electrical and Electronic Engineering
University College of Swansea

IMPLANT FOR BLADDER CONTROL

You may be interested to know that since the article on the electronic implant for bladder control was published (January issue) the device is continuing to be used to help paraplegic patients. The MRC workers who developed the implant tell me that 36 patients have now been fitted with this neurological prosthesis.

May I please correct a couple of small errors which came into the article during your preparation for publication? First, the article should have stated that the patient's hand-held transmitter (Fig. 8) was developed by T. A. Perkins of the MRC Neurological Prostheses Unit. Secondly, reference 3 should be to *Proc. IEE*, and not *IEEE*.

Tom Ivall
Staines
Middlesex

BEHIND THE MICRO

I've just read your articles 'Behind the micro' with interest, since I am thinking of expanding my interests in that direction.

Interesting . . . Well, yes, but I feel the writers haven't ever been in an actual shop to make enquiries!

The problem is, alas, compatibility. It's all very well to say that peripherals are available, but if I plug a device made by X into Y's computer, will it work – or will I get a cloud of smoke?

Don't tell me to 'consult the literature'!

So far as I can see, it is deliberately written in such a way as to discourage any such experiments!

I know what I want . . . but to do it I need to join together gadgets from SIX different makers! But can I, I just don't know!

Ronald G. Young
Peacehaven
East Sussex

DEAD WATCH TIMERS

To cope with just the sort of situation referred to by A. Roscoe under "Thunderstruck" (*Letters* February) we routinely include a "dead watch timer" in most of our new products. We also recommend our clients to use a power supply that outputs an advance warning of impending failure. These two hardware features when well integrated into the software enable mains-related problems to be dramatically reduced, provided a third and equally vital facility is incorporated: an area of battery-backed ram to hold critical variables.

The basic idea of the dead watch timer is to have the software periodically trigger a, retriggerable monostable. As long as the software does this the monostable is prevented from reaching time out. If this happens a maskable interrupt is forced into the microprocessor. This causes activation of a special restart routine.

These facilities are essential when the system is required to "remember" long-term accumulating variables e.g. p-i-d controllers.

Steven Harris
Lodge Associates
Portslade
East Sussex

INDUCTANCE MEASUREMENT

I don't know whether the subtitle 'Simple practical method, hard to find in the textbooks' is due to the author, D. R. Fownes, or to you, but while I agree with the first half of it I think I have reason to be surprised by the second. From the sales and library loans, I venture to claim that the obvious textbook in which to look for simple practical methods of measuring inductance is my 'Radio & Electronic Laboratory Handbook', and Mr Fownes's method has been described in every edition of it from the first in 1938 (issued then by WW) to the 9th dated 1980. It was entitled 'The Three-voltages Method'.

I am obliged to Mr Fownes for deriving a simple formula for calculating the inductance. On the other hand most iron-cored inductors need to be measured with known variable amounts of d.c. flowing through them, and my measuring circuit has always shown this. Perhaps nowadays my stress on the voltmeter taking negligible current is no longer needed.

By the way, my letter in your October issue questioning the appropriateness of the term 'current dumping' having evoked no defence of it, I infer that there is no defence, and it is yet another misuse of a word in electronic terminology (e.g. 'slew rate', 'mixer' and 'attenuation distortion').

M. G. Scroggie
Bexhill
East Sussex

THE NEW BUREAUCRACY

Engineers will be regretful, but not surprised, that only one programmer in the country failed the von Neumann loyalty test. (*Wireless World* Letters, August and October 1983.)

However, D. W. Scott then writes,

> "He – and MAPCON – still have not realised that machine architecture need have little to do with its technological implementation."

This statement beautifully illustrates the blocking position taken by programmers, preventing advances in the art. If, for instance, we can simulate a cam in a ram, then why should we ever want to build a cam? (If we can get there by horse and carriage, then why do we need a motor car?)

Ivor Catt
St. Albans
Hertfordshire

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MICRO PRODUCTS

Apple Macintosh

The latest Apple computer is to be launched in the UK in April. Known as the Macintosh, it offers similar facilities to the Apple Lisa; it is menu driven from a display resembling a desk top where the facilities that a business executive may need can be pointed to with a cursor and selected for use by the push of a button. So notes may be scribbled on a pad, memos, expenses sheets, calculator, graph pad etc. are all available on the screen. They are selected by moving the cursor with a 'mouse', a small rolling box whose movements across the desk top are reproduced on the notional desk-top on the screen.

Macintosh uses a 16/32-bit Motorola MC68000 processor and includes 64K of rom and 128K of ram. A 512K version is due later in the year. The operating system is both rom and disc based and the computer includes a 3.5in disc drive. Each disk has a capacity of up to 400Kbytes. There is a port for an optional additional disc drive, two RS232C/422 serial ports for attaching printers or for communicating through a modem. Sound facilities give polyphonic sound over more than 12 octaves and are capable of reproducing human speech through the built-in speaker. Apple is developing a point-to-point interconnection bus and the interface is already built in to Macintosh. The integral 9in c.r.t display offers a bit-mapped 512 by 342 pixel resolution. There is a clock/calendar chip. Although not intended as a portable computer, it does have a carrying handle and at 7.7kg it weighs less than many so-called portables.

The price of Macintosh has not yet been fixed, though in the US it is likely to be about $3,000.

Apple have produced two software packages for Macintosh; MacWrite word processing and MacDraw graphics. Lotus have developed a Macintosh version of 1-2-3, a spread-sheet and filing system and a number of software houses are preparing programs. Apple Computer (UK) Ltd, Eastman Way, Hemel Hempstead, Herts HP2 7HQ.

WW 303

Oric Atmos

The Oric 1 computer at the cheap home computer end of the market was never very successful. The makers made a mistake in providing prototypes rather than complete machines to the computer press who were very unkind to it. A cynical definition of the Oric 1 was "prototype for the Oric 2". The faults were compounded by the non-appearance of many promised additions and peripherals; a disc drive, a communications modem with a teletextdecoder, a rom cartridge with "super extended Basic as powerful as the BBC".

The principal difference between the Oric 1 and the Atmos is the new version of the rom operating system which has, according to Oric, not only ironed out the Oric bugs but also some others inherent in the Microsoft software. A number of additional commands have been added; especially to the cassette routines so that programs can now be verified after they have been saved. Arrays can now be stored and recalled without recourse to machine code.

The Basic is adequate and most of the commands that you would expect to find are there. We were surprised to note that there has been no attempt to improve on the abysmal line editing facility. In this respect many other computers also claiming to use 'extended Microsoft Basic' are much better (for example the Dragon and the Tandy Color Computer). Serial attributes, to change the colour or style of characters on the screen, take some getting used to but have the advantage of taking up very little memory space.

Also provided is a cassette which has a graphics display program showing how good the display facilities are. Included is an animation of a flying duck which is very impressive especially as it is written in Basic. The program may be broken in to and listed to show how a particular effect is achieved. Also on the tape is a machine-code facility to overcome some of the frustrations of program loading mentioned above; it enables the user to override the error-checking routine. This overcomes the most common problems caused by errors inthe 'header' and leading portion of the tape, which have no relevance to the actual program.

The specification for the Atmos includes a 6502A processor running at 1MHz, 48K ram, 16K rom, 57 keys and a concealed reset button for a 'warm' reset; i.e. one that does not lose any data. The screen format offers eight foreground and the same eight background colours for a text screen of 40 columns of 28 lines and a character set very similar to teletext (and BBC Mode 7) with standard ascii characters, double height and flashing characters and up to 80 user-defineable characters. High-resolution graphics offer 240 by 200 pixels in eight colours and there are line, circle and point facilities. Areas of the screen may be "filled" with a chosen colour. Three channels of sound over eight octaves with additional white noise and envelope control are output through a powerful internal speaker or may be output to a hi-fi system. There is an expansion port for the addition of some peripheral equipment, such as disc drives or a-to-d converters, a Centronics printer port, a modulated tv output as well as an RGB output for a colour monitor.

The Oric printer/plotter using four-coloured ball point pens has been re-styled to match the Atmos colour scheme and the long-promised 3in disc drive with 160Kbytes per side and a transfer rate of 250Kbit/s has been announcedbut at the time of writing we have not been able to get hold of one.

Those who already have an Oric 1 need not despair or throw it in the bin. Oric are looking "very seriously" at the possibility of providing an upgrade kit to turn an Oric 1 into an Atmos. This could cost about £50. 160 000 Oric 1s were sold so this could be a major operation. Oric Products International Ltd, Coworth Park, London Road, Ascot, Berks SL5 7SE.

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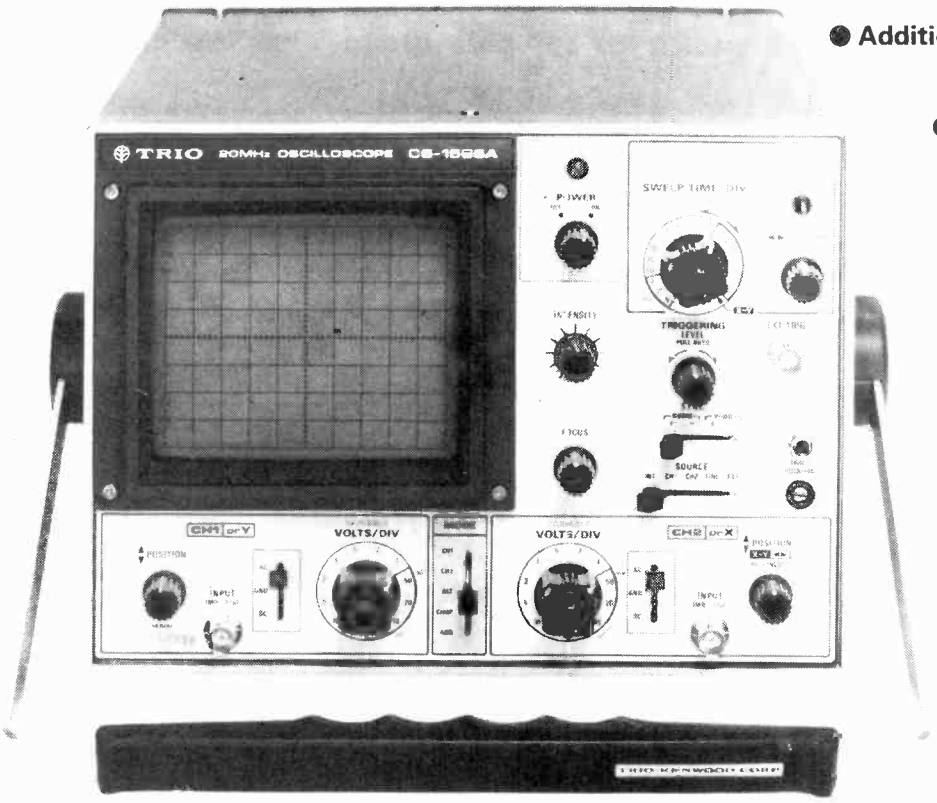

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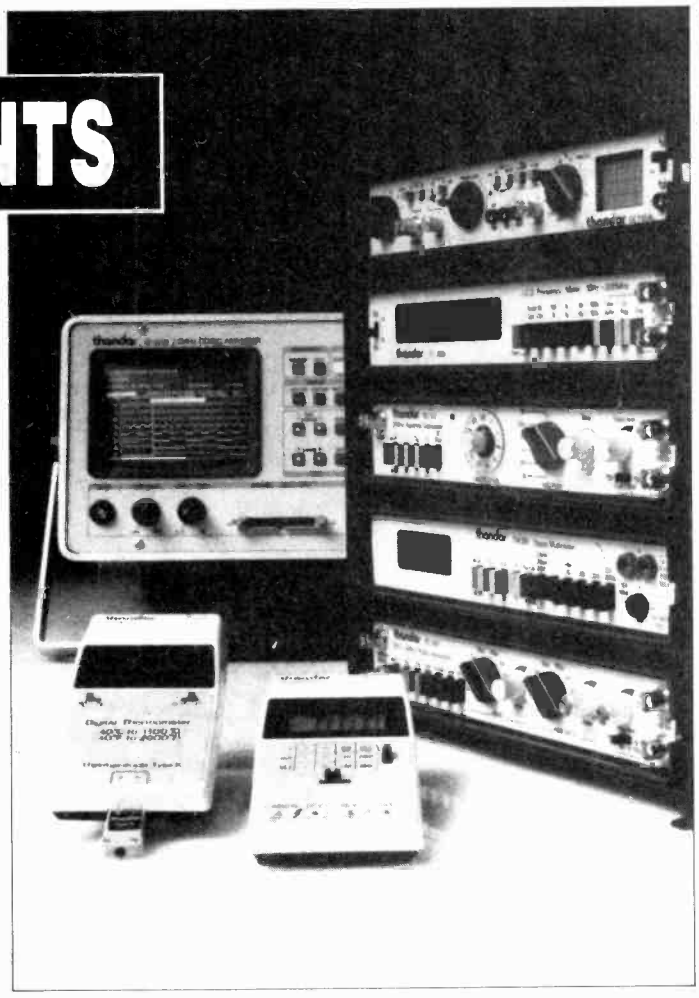

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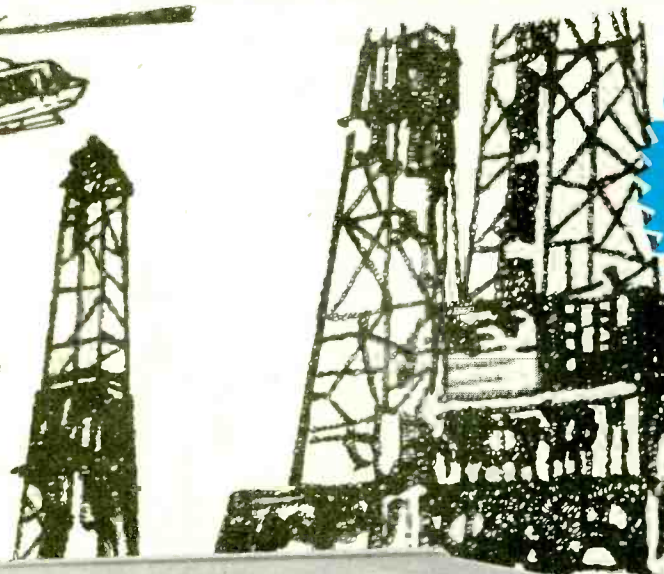

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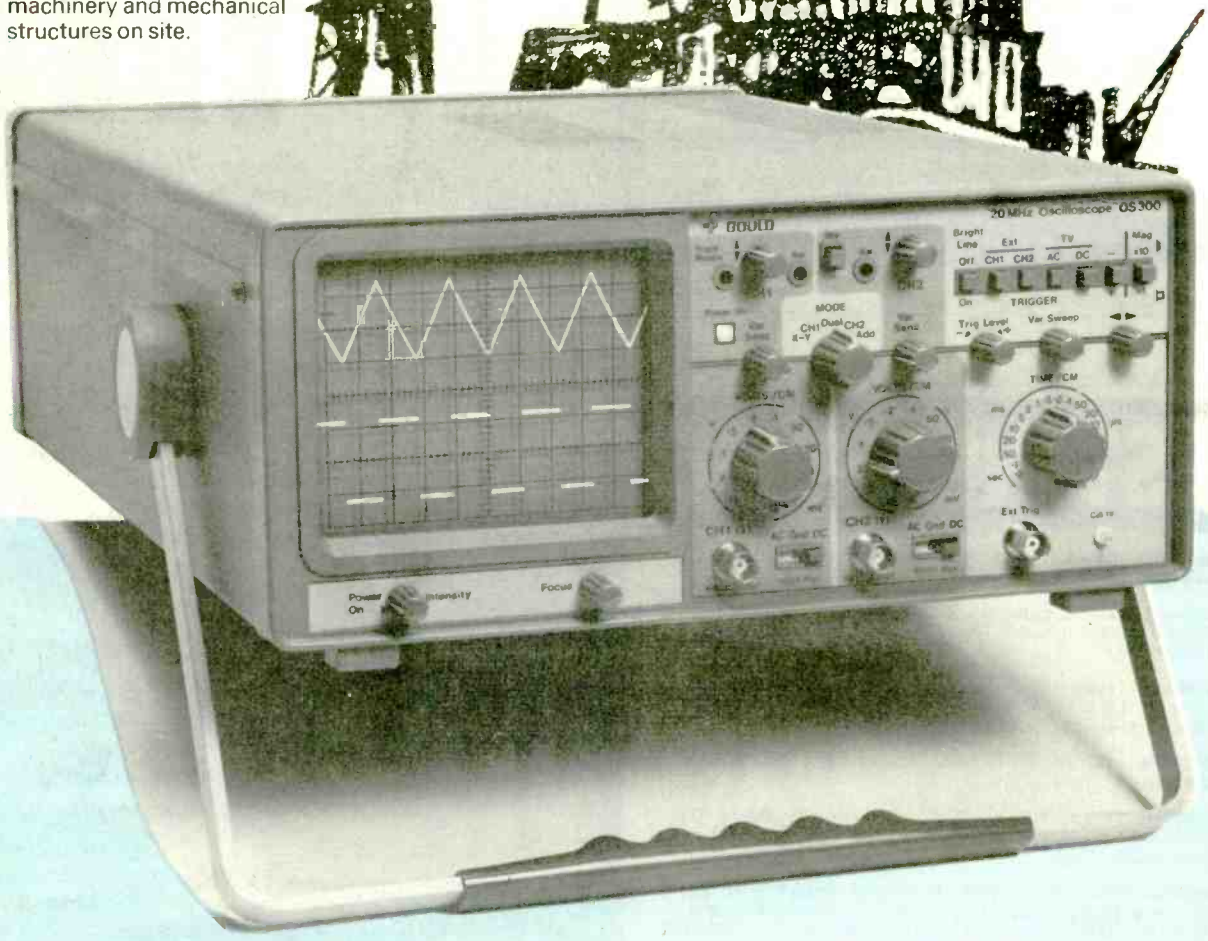

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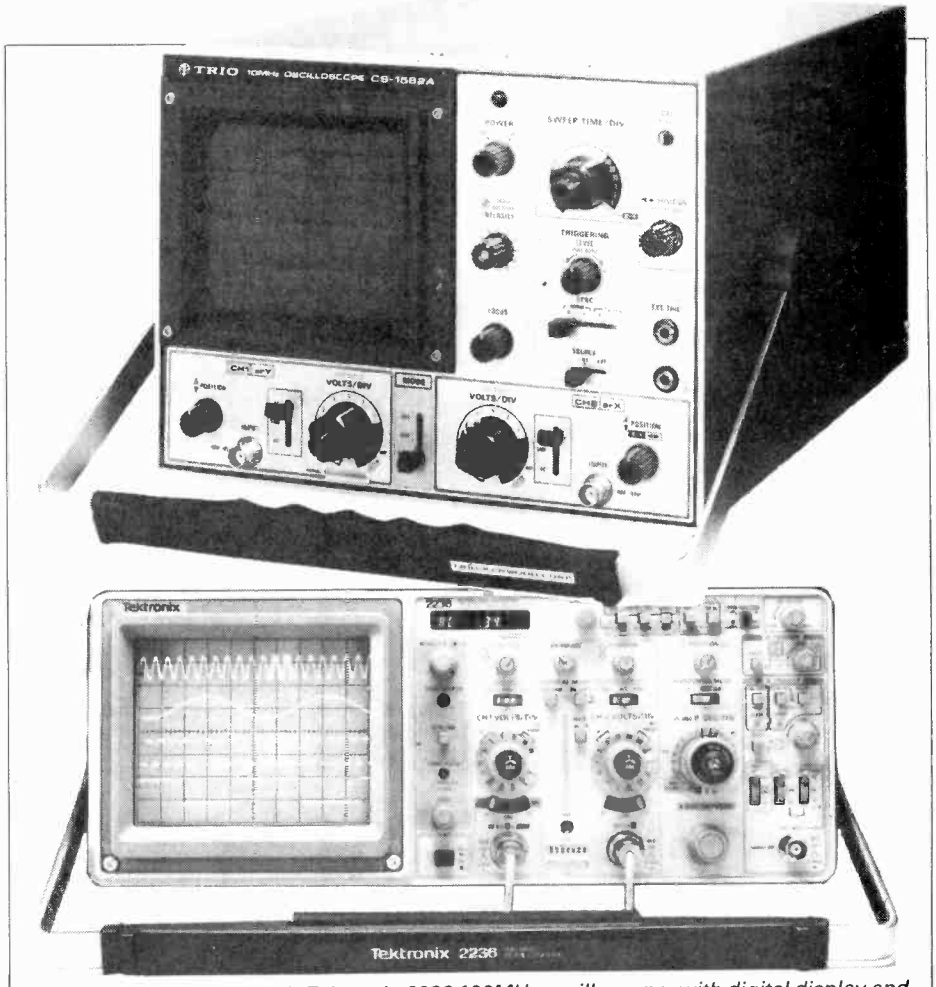
Instruments currently available on the UK market

In the time since the last oscilloscope review appeared in *Wireless World* – a survey of portable types – it has become unnecessary to classify them in such a way, since the majority are now easily portable. Indeed, it is becoming increasingly difficult to classify oscilloscopes in any way at all: some of the functions of the more modern test instruments are those of an oscilloscope, but in some cases form only a small part of the instrument's repertoire. Logic analysis, spectrum analysis, waveform recording and even computing are now taken in hand by the latest, high-end equipment and the distinctions become blurred.

Not many instruments now exist of the type intended solely for displaying a trace. Very extensive measuring facilities in both axes are offered and, in the case of digital oscilloscopes, these can be made to an extremely high level of accuracy, sometimes with the result displayed on the screen.

To enable readers who may be out of touch with modern oscilloscope design and the characteristics and facilities provided, the terms used in manufacturers' data sheets need explanation. The first part of this survey is therefore devoted to a glossary of terms.



10MHz Trio CS1562A (top). Tektronix 2236 100MHz oscilloscope, with digital display and multimeter function.

Signal path

Bandwidth is the passband of the Y amplifier or amplifiers, measured at the -3dB points. Normally, oscilloscope amplifiers are directly coupled, so that the amplitude response extends to zero frequency: a capacitor can usually be switched in to allow small events on a large d.c. level to appear on the screen, the bandwidth then being limited to around 10Hz rather than zero.

In some cases, it is possible to offset the d.c. by means of a panel control to achieve the same effect without loss of low frequencies. The bandwidth of the Y amplifier is the characteristic used to indicate the kind of oscilloscope under consideration.

Rise-time is the response time of the Y amplifier to an infinitely steep step. If the amplifier's frequency/amplitude response has a smooth roll-off at high frequencies, as they all do, then the rise time in nanoseconds can be found from the bandwidth in megahertz by the expression $t_r = 350/f$. A bandwidth of 100MHz will give rise to an amplifier rise time of 3.5ns. Since, however, voltage steps are not infinitely steep, the displayed rise time (taken from 10% to 90% of the excursion) will always be longer than this, and is equal to $\sqrt{t_{ra} + t_{rs}}$, where t_{ra} is the amplifier rise time and t_{rs} is that of the step itself.

Deflection factor is often termed Y sensitivity and is the amount of vertical deflection of the spot on the screen for a given input voltage to the amplifier. It is measured in millivolts per division of the graticule or per centimetre. A common figure is 5mV/div and may not be constant over the whole bandwidth of the amplifier: sometimes an increased sensitivity can be obtained by sacrificing bandwidth and rise time. The sensitivity is controlled at the front panel by a switch, working in the 1, 2, 5 sequence, and often there is a two-position auxiliary switch to increase the sensitivity by a factor of 10. When a continuously variable gain control is fitted, the amplifier is not calibrated unless the control is at the end of its travel.

Display modes describe the way in which the input signals are presented on screen, in dual-trace oscilloscopes. A front-panel control selects for display channel 1, channel 2 (one of which can often be inverted), ch1 and ch2 alternately, ch1 and ch2 effectively simultaneously by chopping from one to the other at high speed so that

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Model	Y bandwidth (MHz)	Y sensitivity (mV/div)	Channels	Max sweep rate (ns/div)	Dual sweep	sweep delay	Y delay line	TV sync	Screen	Acceleration potential	Price		Reply card number
BK/Dynascan													
1590	100	5 (×5)	4	20 (x10)	●		●	●	8x10cm	16kV	1780	V-mode trigger	WW501
1570	80	5 (×5)	4	50 (x10)	●		●	●	8x10cm	12kV	1285	V-mode trigger	
1560	60	1 (CH3-0.1)	3	500 (x10)	●		●	●	8x10cm	16kV	1139	Trig. holdoff. Auto focus. XY operation. V-mode	
1540	40	1	2	100 (x10)	●		●	●	8x10cm	12kV	941	XY. V-mode	
1522	20	1	2	200				●	8x10cm	6kV	670	XY. V-mode	
1466A	10	1	1	500 (x10)				●	8x10cm	2kV	380	XY	
1476A	10	1	2	500 (x10)				●	8x10cm	2kV	460	Dual-trace version of 1466A	
1535A	35	2	2	100 (x5)			●	●	8x10cm	6kV	745	Variable trigger hold off. Differential	
1479B	30	5	2	200 (x5)			●	●	8x10cm	6kV	700	XY. R.f. detector triggering	
1477	15	10	2	500 (x5)				●	8x10cm	2kV	453	XY	
1405	5	10	1	1000 aprx.							188	Free-running time base, synchronized	
1420	15	10	2	1000 (x10)				●	4x5cm	1kV	650	Mains/battery	
1435	15	2	2	500 (x5)				●	4.8x6cm	1.5kV	677		
Crotech													
3337	30	5	2	200 (x5)			●		8x10cm	10kV	405	XY	WW502
3132	20	2	2	500 (x5)				●	8x10cm		283	XY. Tester for passive and active components	
3034	15	5	2	500 (x2.5)				●	5.3x6.6cm	2kV	370	Battery. XY. Battery saver	
3033	15	5	1	500 (x2.5)					5.3x6.6cm	1kV	287	Battery saver	
3030	15	5	1	500 (x2.5)					5.3x6.6cm	1kV	154	Component tester	
3035	10	5	1	500 (x2.5)					8x10cm	2kV	174	Component tester	
Datacheck													
1200B	2.5	50	1	2000 (x10)					5x4.2cm	1.8kV	4223	Modular. Up to 7 units plugged into rack. Dual, selectable inputs	WW518
1200B(S)	2.5	50	1	20,000 (x10)					5x4.2cm	1.8kV	4545		
Farnell													
DT12-5	12	5	2	500 (x5)				●	8x10cm	2kV	245	XY	WW503
DTV 12-14	12	5	2	500 (x5)				●	8x10cm	2kV	265	More flexible Y display options. Fine X and Y controls	
DTC-12	12	5	2	500 (x5)				●	8x10cm	2kV	359	Component tester	
DTS-12	12	5	2	500 (x5)					8x10cm	2kV	795	Digital storage version of DT12-5. Max. event speed 100kHz. Max. sample rate 0.5MHz.	
Gould													
OS300	20	2	2	500 (x10)				●	8x10cm		325		WW504
OS8100	100	2	2	50	●	●			8x10cm	16kV	8400	Micro-controlled. Menu display. Auto calculations	
Hameg													
HM103	10	5 (x2.5)	1	500 (x2.5)				●	6x7cm	1.8kV	158	Component tester	WW505
HM203	20	5 (x2.5)	2	500 (x12.5)				●	8x10cm	2kV	264	Component Tester	
HM204	20	5 (x2.5)	2	500 (x2.5)				●	8x10cm	2kV	365	Trig. delay	
HM605	60	5 (x5)	2	50 (x10)			●	●	8x10cm	14kV	487	Trig. Delay. Trig. hold off	
HM705	70	5 (x2.5)	2	50 (x10)			●	●	8x10cm	14kV	588	Trig. delay	
Hewlett-Packard													
1980	100	2	2	5	●	●			10x12cm	22kV	8516	XY Trig-view. Trig delay. Auto-ranging trig-level, deflection factor and sweep speed	WW521
Hitachi													
V-212	20	5(x5)	2	200 (x10)				●	8x10cm	2kV	295	XY. V-mode	WW506
V-222	20	5 (x5)	2	200 (x10)				●	8x10cm	2kV	340	D.c. offset for small signal viewing in presence of d.c. Avoids a.c. coupling. V-mode	
V-422	40	5 (x5)	2	200 (x10)			●	●	8x10cm	12kV	510		
V-203F	20	5 (x5)	2	200 (x10)				●	7.5x9.5cm	2kV	355	Trig. delay	
V-353F	35	5 (x5)	2	200 (x10)			●	●	7.5x9.5cm	5.2kV	495	Trig delay	
V-1050F	100	5 (x10)	4	20 (x10)	●		●	●	8x10cm	20kV	1200		
V-650F	50	5 (x5)	3	50 (x10)	●		●	●	8x10cm	10kV	750	A-trigger view on third channel	
V-509	50	5 (x5)	2	100 (x10)			●	●	5x6.3cm	12kV	995	A.c.-d.c. Trig. delay	
V-209	20	5 (x5)	2	500 (x5)				●	5x6.3cm	1.5kV	525	A.c.-d.c.	
Iwatsu													
SS5702	20	5(x5)	2	100 (x5)				●	8x10cm	2kV	290	XY. Ac/dc	WW519
SS3510	50	2 (x5)	2	100 (x10)	●		●	●	5x6.4cm	12kV	1250	Batt/mains, 8.25x4x11.875in. 8.6lb	
SS5710	100	1	4	20 (x10)	●		●	●	8x10cm	20kV	745		
SS5711	60	1	4	50 (x10)	●		●	●	8x10cm	15kV	1150		
Kikusui													
COS6100	100	5 (x5)	5	20 (x10)	●		●	●	8x10cm	20kV	1145	XY. Displays CH1, CH2, CH3, A trig, B trig. and add simultaneously. Trig. hold off	WW511
COS3010	15	5 (x5)	2	500 (x5)				●	7.6x6.4cm	1.5kV	395	Mains/battery. Trig. hold off. XY	
COS5060	60	5 (x5)	3	50 (x10)	●		●	●	6in rect.	12kV	735	8 traces. XY	
COS5041	40	5 (x5)	2	200 (x10)	●		●	●	6in rect.	12kV	535		
COS5040	40	5 (x5)	2	200 (x10)			●	●	6 in rect	12kV	445	XY. Trig. hold off	
COS5021	20	5 (x5)	2	200 (x10)	●			●	6in rect	2kV	395	Trig. hold off. XY	
COS5020	20	5 (x5)	2	200 (x10)				●	6in rect	2kV	280	XY	
Leader													
LBO514A	15	5 (x5)	2	500 (x5)					8x10cm	1.8kV	323		WW507
LBO522	20	5 (x10)	2	200 (x5)				●	8x10cm	2	349	Trig. hold off	
LBO523	35	5 (x10)	2	200 (x10)			●	●	8x10cm	7kV	501	XY	
LBO524	35	5 (x10)	2	200 (x10)	●		●	●	8x10cm	7kV	615	XY	
Non-Linear													
MS215	15	10	2	100					2.5x3.2cm	700V	445	Batt/mains (110V a.c.) Measures 2.9x6.4x8in.	WW520
MS230	30	10	2	50					2.5x3.2cm	700V	540	Batt/mains (110V a.c.)	
Philips													
PM3262	100	2	3	50 (x10)	●		●		8x10cm	17kV	1695	Trig. hold off. Trig. view	WW512
PM3267	100	2	3	50 (x10)	●		●	●	8x10cm	10kV	1250		
PM3264	100	2	4	50 (x10)	●		●		8x10cm	17kV	3550	Trig. view on fifth channel	
PM3263	100	2	2	50 (x10)	●		●		8x10cm	17kV	3030	Trig. view. Dual delay for time interval measurement	
PM3254	75	2	1	50 (x10)	●		●		8x10cm	10kV	1145	Trig. view on third channel	
PM3256			2								1245	As3254 with two channels	
PM3215	50	2	2	100 (x10)			●	●	8x10cm	10kV	695	XY. Trig. hold off	
PM3217	50	2	2	100 (x10)	●		●	●	8x10cm	10kV	850	As 3215 with delayed time base	
PM3233	10	2	2	200 (x5)			●	●	8x10cm	10kV	960	Dual beam	
PM3211	15	2	2	500				●	8x10cm	4kV	660		
PM3207	15	5	2	500 (x5)				●	8x10cm	2kV	325	X and Y sensitivity equal	

continued on page 61

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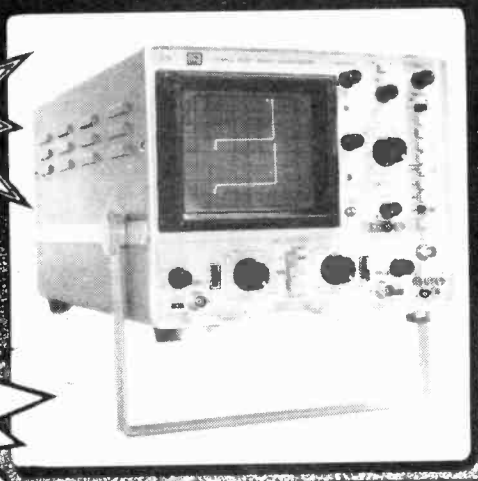

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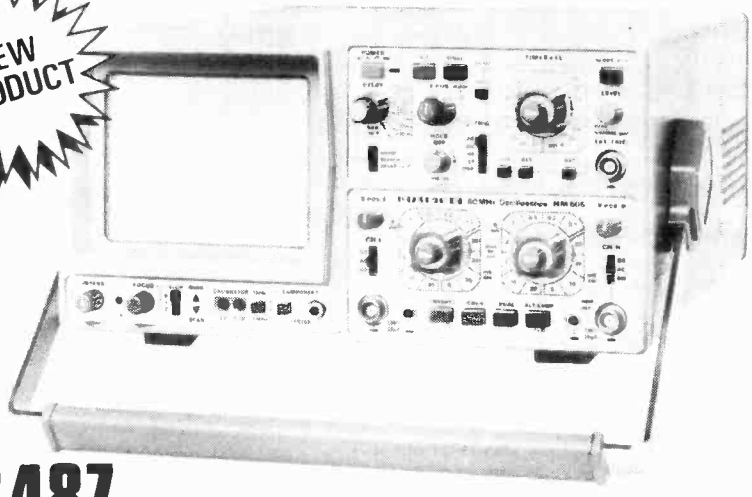

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A high sensitivity (2mV) oscilloscope with an advanced digital delay system for TV line selection providing an exceptionally stable and inherently jitter-free display from inherently unstable mechanically reproduced video recording systems, whether tape or disc. The digital counting system operates on line numbers (selected by a 10-turn vernier delay control), not on elapsed time thus guaranteeing jitter-free traces even after a delay of almost a full field.

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continued from page 58

Model	Y bandwidth (MHz)	Y sensitivity (mV/div)	Channels	Max sweep rate (ns/div)	Dual sweep	sweep delay	Y delay line	TV sync	Screen	Acceleration potential	Price		Reply card number
Rohde & Schwarz													WW508
BOP	30	5	2	200 (x10)		●	●	●	8x10cm	6kV			
BOL	100	5	4	20 (x10)	●	●	●	●	8x10cm	18kV		Displays eight traces, with trig. view	
Scopex													WW509
14D-10V	10	2	2	1000 (x5)				●	8x10cm		325	XY. Tv line delay. Tv & video servicing	
14D-15	15	5	2	1000 (x10)				●	8x10cm	2kV	285	XY	
Scopextra FC	15	5	2	1000 (x10)				●	8x10cm	2kV	365	As 14D-15 with add-on function generator	
Scopextra PS	15	5	2	1000 (x10)				●	8x10cm	2kV	385	As 14D-15 with add-on dual power supply	
Bridage													
SB121	5	50	1	1000					5x6cm		175		
DB242	5	50	2	1000					5x6cm		195	As SB121 but two channels	
Siemens													WW513
D1004	50	2	2	10	●	●	●		8x10cm	11kV	1150	XY	
Rest of Siemens range under revision													
Solartron													WW510
5220	100	5	2	50 (x10)	●	●			8x10cm	12kV	1545	Dig. time measurement	
5224	100	5	4	50 (x10)	●	●		●	8x10cm	12kV	1881	As 5220 but four channels	
5222	50	5	2	100 (x10)		●		●	8x10cm	10kV	1279	XY. Trig. delay	
5013	15	5	2	1000 (x5)				●	8x10cm	2kV	477	XY	
5023	15	5	2	1000 (x5)				●	8x10cm	2kV	448	As 5013, with fine gain adj. and A±B	
5024	10	5	4	1000 (x5)				●	8x10cm	2kV	988	A.c./d.c. XY	
5025	25	5	2	200 (x5)			●	●	8x10cm	4kV	778	XY	
5500							●		10x12.5cm	20kV	2633	XY. Mainframe with probe power. R version rack mount	
											1208	D.c. offset. 5500 plug-in	
5522	175	5	2								895	5500 plug-in	
5532	85	2 (x5)	2								778	Differential amp. for 5500. C.m.r.r. 100dB at 20μV and 100kHz	
5523	1	0.02	2										
5533	85	1	2								1416	Diff. comparator for 5500. C.m.r.r. 86dB at 1mV and 100kHz	
				20 (x10)	●						964	Dual time base for 5500	
5546													
5539	>1GHz	2 (x2.5)	2	0.02			●				2264	Sampling plug-in for 5500	
Tektronix													WW514
2337	100	5 (x2.5)	2	50 (x10)	●	●			6.4x8cm	18kV	2695	Trig. view. Trig. hold off. XY. D.v.m. Diff. time	
2336	100	5 (x2.5)	2	50 (x10)	●	●			6.4x8cm	18kV	2274	As 2337 without d.v.m.	
2235	100	5 (x2.5)	2	50 (x10)	●	●			6.4x8cm	18kV	2122	As 2336 without diff. time measurement	
2213	60	2	2	50 (x10)		●		●	8x10cm	10kV	880	Trig. hold off. Trig. delay	
2215	60	2	2	50 (x10)	●	●		●	8x10cm	10kV	1063		
335	35	10	2	200 (x10)	●	●			6.4x8cm	12kV	2796		
T422R	15	2	2	200 (x10)		●		●	8x10cm	12kV	765	XY. Rackmount	
308	5	5	2	1000 (x10)					5x6.3cm	2kV	333	D.v.m.	
221	5	5	1	1000 (x10)					3.1x5.2cm	1kV	1826	Mains/battery	
213	1	5	1	2000 (x5)					3.1x5.2cm	1kV	2327	D.v.m. display on screen. Mains/battery	
212	0.5	1	2	5000 (x5)					3.1x5.2cm	1kV	1645	Mains/battery	
7104	1GHz		2	0.2 max			●		6.8x8.5cm	12.5kV	19821	Mainframe. V and I calibrator	
Y plug-ins from 75 MHz to 1GHz, from 1m V/div.													
Y plug-ins from 0.2ns/div, delayed sweep, programmable													
5440	50 max		2	10max			●		9x12cm	15kV	2438	Mainframe	
5A38	35	10 (x2.5)	2								596	5440 Y plug-in	
5A48	50	1 (x2.5)	2								879	5440 Y plug-in	
5B40				100 (x10)							614	5440 X plug-in	
5B42				100 (x10)	●						1131	5440 X plug-in	
465	100	5	2	200 (x10)	●	●			8x10cm	18kV	2852	Trig. view	
Thandar													WW515
SC110A	10	10	1	100				●	3.2x2.6cm			D.c. or a.c. adaptor	
Trio													WW516
CS2110	100	5 (x5)	4	20(x10)	●	●		●	8x10cm	20kV	1499	Four channels, eight traces	
CS2070	70	5 (x5)	4	50 (x10)	●	●		●	8x10cm	12kV	949	V.c.r. and video disc work	
CS1577A	35	2	2	100 (x5)		●		●	140mm tube	6kV	499	Trig. hold off. XY	
CS1830	30	5 (x2.5)	2	200 (x5)		●			140mm tube	6kV	583	Trig. delay. Trig. hold off. XY	
CS1010	10	1	1	500 (x10)				●	8x10cm	2kV	269	V-mode	
CS1012	10	1	2	500 (x10)				●	8x10cm	2kV	289	As 1010, but two channels	
CS1020	20	1	1	200 (x10)				●	8x10cm	6kV	339		
CS1022	20	1	2	200 (x10)				●	8x10cm	6kV	359	As 1020, but two channels	
CS1566A	20	5	2	500 (x10)				●	140mm tube	2kV	349	XY	
CS1820	20	5 (x2.5)	2	200 (x5)				●	140mm tube	6kV	442	Trig. hold off. Trig. delay	
CS1720	20	2	2	200 (x5)		●		●	7.6x9.5cm	6kV	1674	Programmable functions	
CS1352	15	2	2	500 (x5)				●	75mm tube	1.5kV	431	Mains/batt. XY	
CS1560A	15	10	2	500 (x5)				●	130mm tube	2kV	325		
CS1562A	10	10	2	1000 (x5)				●	130mm tube	2kV	279		
CS1559A	10	10	1	1000 (x5)				●	130mm tube	2kV	265		
CS1575	5	10	2	500					130mm tube		358	Displays CH1, CH2, Lissajou and 0° phase simultaneously	
Vu-data													WW517
4100	100	5	2	50 (x10)			●		2x2.5cm	6kV	1850		

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the chopping is invisible, ch1 minus ch2 and ch1 plus ch2.

The 'alternate' and 'chopped' presentations perform roughly the same function. At low and middle frequencies, chopping between channels occurs many times during the time-base sweep and is generally not phase-related: it cannot, therefore, be seen and the two traces appear simultaneously. At higher frequencies, the chopping may occur only a few times during a sweep and may become visible, so that each trace must then be triggered alternately to give once again an effective simultaneous display of the two signal channels.

Input impedance at the Y inputs is usually 1MΩ with 20-30pF in parallel. In the event that the signal under inspection is from a high-impedance source and would be deformed by this input arrangement, most makers provide as an accessory a probe which, at the expense of a decrease in sensitivity by a factor of 10, gives 10MΩ and 2pF at the probe tip. Even better performance is provided by probes with a field-effect transistor source-follower, which can give 1MΩ and around 1pF even when the input of the oscilloscope is a 50Ω coupling – often found with high-frequency instruments.

Input coupling selects a coupling capacitor when the d.c. component of a signal is too high to allow inspection of small features which need a high sensitivity. It is usually marked AC, DC and GND, the latter earthing the input to provide a 0V reference on the display.

Delay line allows inspection of the leading edge of a transient. Since the signal itself normally triggers the time-base, and since the time-base takes a certain amount of time to fire after the trigger, the leading edge would have occurred before the sweep started, without the delay line.

With the line in the signal path, the signal is delayed by a fraction of a microsecond until the time-base is operative. The delay line does not deform the signal.

Time-base

Modern time-bases are of the triggered variety – they run when triggered by a pulse. The rate at which the spot sweeps across the screen is controlled from a front-panel switch, usually in a 1-2-5 sequence, and by an uncalibrated variable control. The fastest sweep provided must spread the rise-time of the Y amplifier over a useful part of the screen; for example, if the bandwidth is 100MHz, giving a rise time of 3.5ns, the highest sweep speed should be around 2 to 5ns per division or per centimetre. It may be that the fastest sweep on the control is ten times slower than this, at around 50ns per division, in which case there will probably be provision to magnify the sweep amplitude to overscan the screen by a factor of 10, effectively multiplying the sweep speed by 10. The result is roughly the same.

Horizontal modes

In dual-trace instruments, delayed sweeps with a number of display modes are commonplace. In essence, the main (A) sweep traverses the whole area of investigation relatively slowly, small events being identifiable but not easily seen. By means of a delay control, the second (B) sweep is triggered just before the area of interest and, since it is set to run much faster than the A sweep, covers only that part. During this time the A sweep only is displayed, the part covered by the B sweep being brightened up.

When the delay and the duration of the B sweep are adjusted as required, the B sweep is displayed across the whole screen, the aforementioned small event now being magnified horizontally. The front-panel mode selector is labelled A, A intensified by B, B, or words to that effect. On some instruments, the delayed and delaying sweeps can be mixed to display both simultaneously. It might be possible to see the small occurrence in the normal way with sweep magnification, if it were near the trigger pulse, but a large magnification on a small trace would almost certainly result in a jittery display: the delaying method avoids this problem.

Triggering

A variety of triggering modes is usually provided. 'Normal' is the condition when the Y signal signal provides a trigger pulse for the time-base, which does not sweep unless the trigger is present. In the 'automatic' mode, the time-base free runs, providing a base-line on the screen in the absence of a Y signal, and locks to an applied signal: it is somewhat similar to the method used many years ago when free-running time-bases were synchronized with the Y signal. A 'single-sweep' facility is sometimes provided, when the timebase fires once on the next trigger after a front-panel button is pressed. Trigger hold-off is useful when, say, one cycle in a long train is to be viewed. It would normally not be easy to trigger the sweep just before the wanted cycle, since as far as the trigger circuit is concerned, all the cycles are identical. With trigger hold-off, pulses can be inhibited until the part to be investigated is reached, whereupon the next trigger fires the time-base, which can then run at the desired speed.

Since the Y signal itself normally provides the trigger, it is necessary to select the exact point on a waveform at which the trigger pulse is generated. The 'level' control sets this in the vertical direction and the 'slope' determines whether the trigger is taken from a positive or negative-going edge. It is usually possible to use an external trigger, selectable from the front panel. Vertical-mode triggering (V mode) enables two traces of differing frequencies to be viewed alternately – normally, triggering from one would give an unlocked display of the other.

In the table, sensitivity and sweep-speed figures are given without taking into account the multipliers shown in brackets. Prices quoted are exclusiive of v.a.t.

For more complete information, insert the **WW No** on the Reader Service Card facing page ££.

Manufacturers

BK/Dynascan. B & K Precision, P.O. Box 27, 39 Whitby Street, Hartlepool, Cleveland TS24 7BR. 0429 75750.

Crotech. Crotech Instruments Ltd, 5 Nimrod Way, Elgar Road, Reading, Berks. RG2 OEB. 0734 866945.

Datacheck. RMR Measurements, 138 Lime Crescent, Cumbernauld G67 3PQ. 02367 28170.

Farnell. Farnell Instruments Ltd, Sandbeck Way, Wetherby, West Yorks. LS22 4DH. 0937 61961.

Gould. Gould Instruments Division, Roebuck Road, Hainault, Essex IG6 3UE. 01-500 1000. Electroplan Ltd, P.O. Box 19, Orchard Road, Royston, Herts ST8 5HH. 0763 45145.

Hameg. Hameg Oscilloscopes Ltd, 74-78 Collingdon Street, Luton, Beds LU1 1RX. 0582 413174. Lawtronics Ltd, 139 High Street, Edenbridge, Kent TN8 5AX. 0732 865191.

Hewett-Packard. H.P. Ltd, Nine Mile Ride, Easthampstead, Wokingham, Berks RG11 3LL. 03446 3100.

Hitachi. Hitachi Denshi (UK) Ltd, 13-14 Garrick Industrial Centre, Garrick Road, Hendon, London NW9 9AP. 01-202 4311.

Reltech Instruments, New Road, St. Ives, Huntingdon, Cambs. PE17 4BG. 0480 63570.

Iwatsu. STC Instrument Services, Edinburgh Way, Harlow, Essex CM20 2DF. 0279 29522.

Kikusui. Telonic Instruments Ltd, 2 Castle Hill Terrace, Maidenhead, Berks SL6 4JP. 0628 73933.

Non-Linear Systems. Lawtronics Ltd, 139 High Street, Edenbridge, Kent TN8 5AX. 0732 865191.

Leader. Thandar Electronics Ltd, London Road, St. Ives, Huntingdon, Cambs PE17 4HJ. 0480 64646. Also Electroplan Ltd, P.O. Box 19, Orchard Road, Royston, Herts. SG8 5HH. 0763 45145.

Philips. Pye Unicam Ltd, York Street, Cambridge, CB1 2PX. 0223 358866. Electronic Brokers Ltd, 61/65 Kings Cross Road, London WC1X 9LN. 01-278 3461.

Rohde und Schwarz. R & S GmbH&Co KG. D-8000 Munchen 80, Mühldorfstrasse 115, West Germany. (089) 4129-1.

Scopex. Scopex Electronics Ltd, 63-65 High Street, Skipton, N. Yorks. BD23 1EF. 0756 69511.

Siemens. Siemens Ltd, Siemens House, Windmill Road, Sunbury-on-Thames, Middlesex TW16 7HS. 09327 85691.

Solartron. Solartron Schlumberger, Victoria Road, Farnborough, Hants GU14 7PW. 0252 544433.

Tektronix. Tektronix UK Ltd, P.O. Box 69, 36/38 Coldharbour Lane, Harpenden, Herts, AL5 4UP. 05827 63141. Also Electroplan Ltd, P.O. Box 19, Orchard Road, Royston, Herts SG8 5HH. 0763 45145.

Thandar. Thandar Electronics Ltd, London Road, St. Ives, Huntingdon, Cambs. PE17 4HJ. 0480 64646.

Trio. House of Instruments, Clifton Chambers, 62 High Street, Saffron Walden, Essex CB10 1EE. 0799 24922. Also Lawtronics Ltd, 139 High Street, Edenbridge, Kent TN8 5AX. 0732 865191.

Vu-data. RMR Measurements, 138 Lime Crescent, Cumbernauld G67 3PG. 02367 28170.

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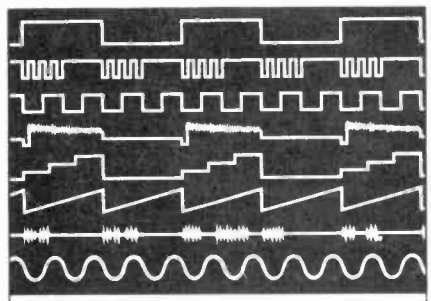

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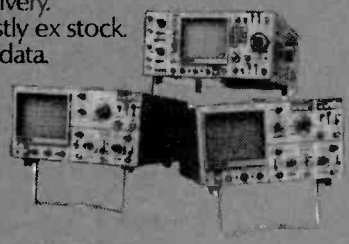

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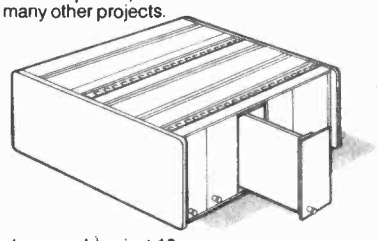

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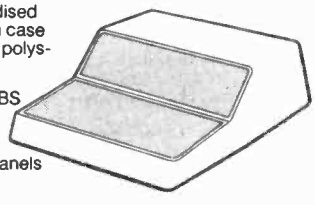
This box is moulded in two sections and has a textured finish. The battery compartment accepts a PP3 or nickel cadmium stack 25 x 45mm long. A circuit board 56 x 105mm may be mounted on three pillars in the base, location being provided by a 3mm spigot. The top moulding will accept a circuit board 71 x107mm.

- Material-Textured ABS
- Colour-Dark brown

Hi-Style Desk Top Case
Designed to house keyboards and displays on two 1,6mm silver anodised aluminium panels. The light brown case is manufactured from high impact polystyrene and has a textured finish.

- Casing-High impact textured ABS
- Colour-Brown, front and base panels 1,6mm satin anodised aluminium



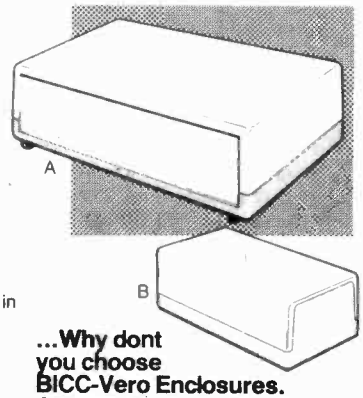
Plastic Boxes
Type A
Plastic boxes consisting of a top and bottom moulding with front and rear aluminium panels, positively retained in the two halves.

- Top and bottom moulding-High ABS.
- Colour-Light grey top: dark grey base.
- Front and rear panels-Satin anodised aluminium 1,6mm thick.

Type B
Constructed of high impact polystyrene, these handsome two-toned grey boxes are suitable for wall mounting and free standing instruments. The two halves of the box are held together by screws inserted from the base.

- Material-High impact polystyrene
- Colour-Top light grey: base dark grey
- Panels-Satin anodised aluminium

Send 50p for a copy of the catalogue with details of the full range available.



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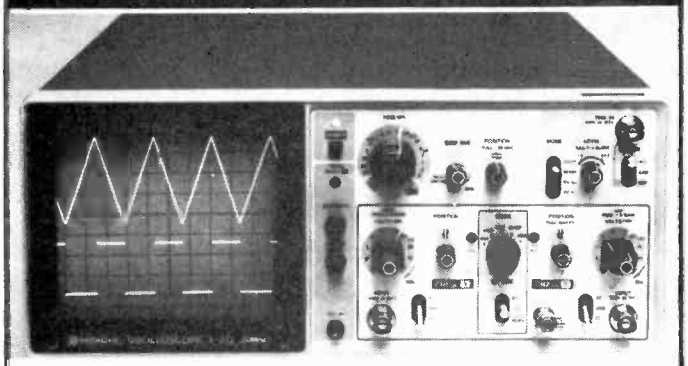

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V-650F	60MHz Dual Timebase	VC-6041	40MHz Digital

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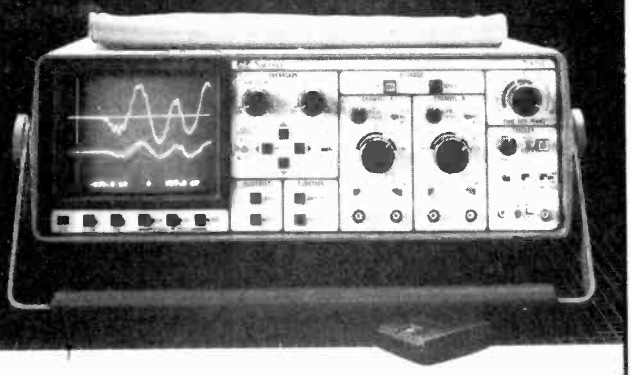

Measure With Accuracy

Precision is simple with the new 3091 digital oscilloscope. High resolution digitizers (12-bit) improve accuracy 10 times over analog scopes. Clear numeric readouts eliminate human error and guesswork in critical situations. Extremely high dynamic range is at your fingertips with zoom expansion for any waveform section up to X60.

Capture Transients With Push-Button Ease

Hold one-time events in each 4k memory and on the screen. You can examine signals from an intermittent problem minutes or even days after the occurence. Using self-explanatory controls, set the scope to capture pre- and post-trigger information. View what led up to an event as well as what occured afterwards.

Store Signals In A Bubble

The 3091's unique bubble memory option provides reliable non-volatile storage in a handy cassette. Controls are simple read-write buttons on the front panel. Store up to ten 2000-point waveforms on each cassette.

Display Mode Options

Select the display mode to suit your measurement needs: YT, XY, or ROLL mode can be combined with either a CURSOR or GRID display. In all modes reference signals may be displayed for comparison with incoming signals. These references may be recently acquired waveforms or signals recalled from bubble memory.

Price-Performance

The 3091 offers many of the advantages of Nicolet's more powerful benchtop models—high resolution, ease of use, data storage and computer interfaces. But it is small (18 lbs.), and so is the price.

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Designing with the 68008 microprocessor

Ideal for use in low-cost, high-volume applications like personal computers and small business machines, the 68008 is an eight-bit microprocessor with a 32-bit architecture. This two-part article describes its main features and how it's used with other microcomputer components like rom, ram and peripheral devices.

by A. J. Barth

All of the microprocessors in the M68000 family of high-performance processors and peripherals, including the 68008, are based on the same 32-bit architecture. The 68008 has an eight-bit external data bus; others have 16 or 32-bit buses. The once-clear divisions between eight, 16 and 32-bit microprocessors are becoming blurred; with the 68008 the designer is now able to have a high-performance microprocessor with a 32-bit architecture in small cost-effective systems using eight-bit data buses.

The architecture of the 68008 is identical to the original member of the family, the 68000, a processor with a 16-bit external data bus. From the programmer's point of view the two processors look identical, so that the 68008 is completely code-compatible with the 68000. This means that any program developed for one processor will run on the other. This is true for object code as well as source code. Other 68000-family microprocessors such as the 68010, virtual memory version of the 68000, and the 68020, very high performance 32-bit mpu, have achitectures which are upward-compatible with that of the 68008, making it easier to upgrade 68008-based systems. For example, any user program written for the 68008 will execute correctly on the 68000, 68010 and 68020 without need for modification.

Using standard rams and roms a smaller minimum-sized system can be constructed with the 68008 than with the 68000. Cost savings are made by producing the 68008 in a 48-pin dual-in-line package as opposed to the 64-pin version for the 68000. Eight pins are saved by halving the reduced data bus. Other minor hardware differences allow more pins to be shed (Fig. 1), for instance a few of the high-order address lines of the 68000 are not brought off-chip on the 68008. Even so, this still allows direct addressing of over one megabyte of memory – huge compared to that of conventional eight-bit microprocessors and more than enough for the low-end applications for which the 68008 is intended.

The 68008 is as fast as the 68000 when accessing byte-sized operands. However, because of its byte-sized data bus the 68008 needs to access 16-bit words as two successive bytes. As a result, the overall throughput of the 68008 is less than that of the 68000. For the same processor clock and for a typical mix of instructions, the 68008's performance is about 60% of that of the 68000. This is still a lot of raw processing power and will meet a need for low-end applications.

Because the architectures of the 68000-family microprocessors are so similar, knowing the 68008 means knowing much about the other processors. The 68008 is characterized by its 'clean', regular and consistent structure and in particular, emphasis was given to the architecture to make it regular with respect to the registers, instructions, addressing modes and data types.

Register set

The 68008 programming model has a large number of general-purpose 32-bit data and address registers, Fig. 2. There are eight general-purpose 32-bit data registers, D_0-D_7, for byte (8-bit), word (16-bit), and long word (32-bit) operations. Seven address registers A_0-A_6 and two system stack pointers A_7, may be used as software stack pointers and base address registers. In addition these registers may be used for word and long-word address operations. All 17 registers may be used as index registers.

High-performance microprocessors are expected to rapidly handle complex functions having a large number of parameters. The 68008 can maintain most or all of these parameters in processor registers, which is both fast and makes the programs efficient and elegant. Microprocessors with only a few registers in such situations need to continuously swap parameters between registers and external memory.

As the 68008 has general-purpose registers, the programmer and not the microprocessor-chip designer decides which registers are used. It does not dictate that certain instructions use certain registers. This not only eases the task of the assembler language programmer but also makes high-level language compiler-generated code more efficient. Many of the instructions and addressing modes which

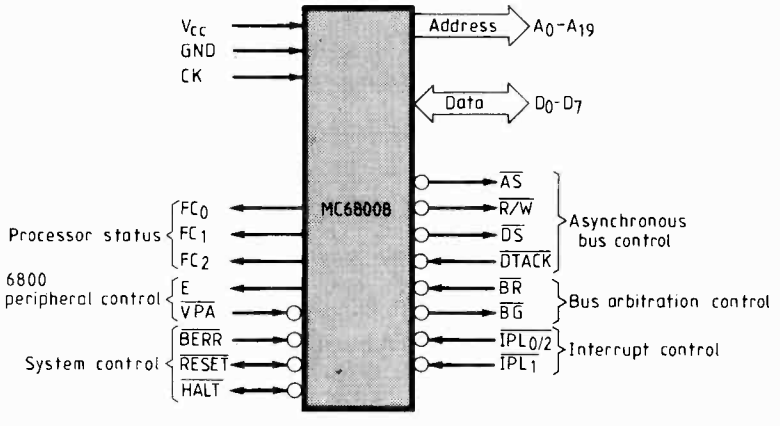

Fig. 1 68008 signal lines. The microprocessor has an internal 32-bit architecture and an eight-bit external data bus. Packaged in a 48-pin package the 68008 has non-multiplexed buses and a non-segmented 1 megabyte address space.

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operate on the address registers may also be used with the 32-bit program counter. This makes it easy to write position-independant software that will execute correctly no matter where the code is loaded in memory.

The 68008 has a 16-bit status register which consists of two parts: a user byte and a system byte. The user byte is accessible by any program and contains the usual condition code flags associated with the execution of instructions, condition like Negative, Zero, Carry, Overflow, etc. The system byte of the status register is accessible only by a supervisory program (usually the operating system) and is used to control the operating mode.

Addressing range

The 68008 has a large linear addressing range. It can directly access one megabyte of external memory without paging or segmentation. Many microprocessors are able to access fairly large memory space but need to do so via a narrow window called a segment or page. This may be useful in a few applications, but in most situations it is an irritating handicap because the programmer is obliged to keep repositioning the window to access the desired location.

Like other Motorola microprocessors the 68008 has memory-mapped i/o. This enables the programmer to use the m.p.u's sophisticated instructions and addressing modes to operate on i/o as well as memory.

Instruction set

The 68008 has a powerful, flexible and easy-to-use instruction set. There are 56 basic instructions (Table 1). This is actually less than the ten-year-old 6800 microprocessor. However because of the regularity of the 68008 architecture, those instructions which use registers may use any register with almost any addressing mode and data type. These permutations yield many thousands of useful operations, compared to less than 100 for the 6800; the 68000 family philosophy being to provide a small number of easy-to-remember and flexible general-purpose instructions.

The instruction set covers the following classes of operations:

- data movement
- integer arithmetic
- logic
- shift and rotate
- bit manipulation
- binary-coded decimal
- high-level language support
- program control and
- system control.

Operations on data in registers and memory are independent of the data size and usually involve a source and a destination operand. The programmer need only remember one mnemonic for each type of operation and then specify data size and addressing modes for both the source and destination operands. Consistency is maintained as all data registers and memory locations may be a source or destination for most operations on integer data.

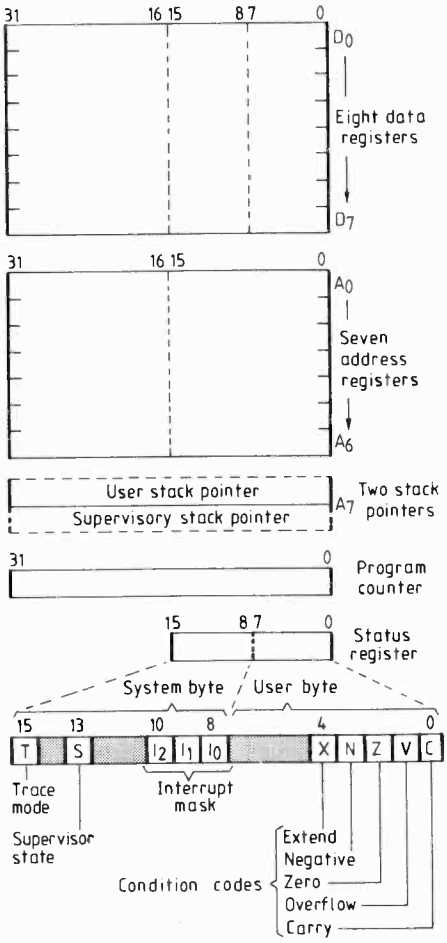

Fig. 2 68008 programming model: eight general-purpose data registers for 8, 16 and 32-bit operations, seven address registers, and two system stack pointers for software stack pointers and base address register. All 17 maybe used as index registers.

Like all M68000 microprocessors the 68008 instructions are implemented by microcode rather than random logic, so that, for example, the execution of undefined instructions no longer leads to unpredictable results.

Data types

The 68008 operates on five main data types. Operations may be on bits, b.c.d. digits, bytes, words and long-words. For integer arithmetic the programmer need not remember different instructions for different data sizes. The required data size is simply appended to the instruction as the program is written.

Addressing modes

An addressing mode is the method by which the data or other operand is accessed by the processor. The availability of powerful and flexible modes usually means performing an operation with just one instruction which would otherwise take many. This results in programs executing faster, being smaller, easier to read and to maintain. The 68008 has 14 powerful addressing modes (See Table 2). They operate consistently and are independent of the instruction itself.

Program privilege scheme

A two-level program privilege scheme provides security and high reliability. Programs should access only their own code and data areas, and ought to be restricted from accessing the information which they do not need and must not modify. Such a scheme not only prevents the deliberate tampering with data but also guards against a faulty program running wild and altering other programs.

The 68008 operates at one of two privilege levels, the supervisor level or at the user level. At the supervisor level programs have access to all processor resources and can execute any instruction or access any register. Normally, only the controlling operating system or its kernel runs at this level. This code is normally relatively small, well-tested and therefore reliable. All the rest of the software, which includes both the utility and application programs, executes at the user level and has access only to a subset of the total processor unit resources, the resources governing control of the system being protected from these programs. If a user-level program attempts to execute a 'privileged' instruction or to access a supervisor register, control is immediately taken away and given to the controlling supervisor program which can take some corrective action.

Interrupt structure

In most applications, programs are seldom executed instruction-after-instruction without a break. The need frequently arises to respond to an event or exception. Such exceptions may be the hardware interrupts caused by external logic, or the software interrupts caused by the recognition of some condition internal to the processor unit. High-performance microprocessors must be able to respond rapidly to a large variety of exceptions with varying degrees of priority.

Three levels of priority are provided for external hardware interrupts. By use of the three-bit interrupt mask in the 68008 status register (Fig. 2) the supervisor program may postpone handling external interrupts with priorities less than that contained in the mask. When an interrupt

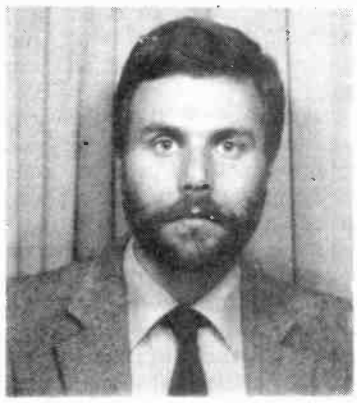

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Table 1. 68008 instruction set

Mnemonic	Description
ADBC	add decimal with extend
ADD	add
AND	logical and
ASL	arithmetic shift left
ASR	arithmetic shift right
B_{CC}	branch conditionally
BCHQ	bit test and change
BCLR	bit test and clear
BRA	branch always
BSET	bit test and set
BSR	branch to subroutine
BTST	bit test
CHK	check register against bounds
CLR	clear operand
CMP	compare
DB_{CC}	test condition, decrement & branch
DIVS	signed divide
DIVU	unsigned divide
EOR	exclusive or
EXG	exchange registers
EXT	sign extend
JMP	jump
JSR	jump to subroutine
LEA	load to effective address
LINK	link stack
LSL	logical shift left
LSR	logical shift right
MOVE	move
MOVEM	move multiple registers
MOVEP	move peripheral data
MULS	signed multiply
MULU	unsigned multiply
NBCD	negate decimal with extend
NEG	negate
NOP	no operation
NOT	one's complement
OR	logical or
PEA	push effective address
RESET	reset external deuces
ROL	rotate left without extend
ROR	rotate right without extend
ROXL	rotate left with extend
ROXR	rotate right with extend
RTE	return from exception
RTR	return and restore
RTS	return from subroutine
SBCD	subtract decimal with extend
S_{CC}	set conditional
STOP	stop
SUB	subtract
SWAP	swap data register halves
TAS	test and set operand
TRAP	trap
TRAPV	trap on overflow
TST	test
UNLK	unlink

is recognised the processor performs an interrupt acknowledgement sequence (IACK). During IACK the peripheral being acknowledged may indicate that program control should be given to any one of 256 interrupt service routines (vectored interrupt method), or to one of three service routines corresponding with the hardware interrupt priority level (autovector interrupt method). Most of the M68000-family peripherals use the vectored interrupt method in which the peripheral provides an eight-bit vector number on the data bus. The 68008 uses this vector number to determine which of the 256 interrupt routine addresses in its interrupt vector table to use. The less sophisticated peripherals use the autovector interrupt method which have seven vectors reserved for them. In either case the external hardware needed to interface both kinds of perpherals to the 68008 is minimal.

Some 68008 instructions are designed to cause internal interrupts, some always and others only upon detection of certain conditions. An example of the last is the execution of a 'privileged' instruction. If a supervisor-level program executes such an instruction, the instruction will execute normally and no exception will occur. However, if a user-level program attempts to execute it, a prividege violation exception occurs and program control is given immediately to the appropriate interrupt service routine.

A number of exceptions correspond to error conditions, either those detected by external hardware or by the processor itself. For example, the Bus Error input (BERR) may be used by external hardware to cause the 68008 to abandon the current bus cycle and give program control to the Bus Error interrupt routine, or, by the simultaneous use of BERR and HALT, to retry the current bus cycle.

A very useful feature is the trace exception, which enables a supervisor-level program to step through a target program on an instruction-by-instruction basis. Each time the target program executes an instruction, no matter which instruction it may be, control is returned to the supervisory program. No external hardware is required to implement the program tracing as it is part of the processor architecture.

Asynchronous data bus

Like most of the other Motorola microprocessors, the 68008 data bus is not multiplexed – the m.p.u. pins used for the data bus are not shared with other signals. Some microprocessors multiplex the data and address buses onto the same pins to reduce the total number of pins. Non-multiplexed microprocessors such as the 68008 require more pins and sometimes a more expensive package. However, non-multiplexed buses have many advantages: they can operate much faster, dissipate less chip power, and do not require external demultiplexing hardware. Analysis shows that multiplexed microprocessor systems are more costly than non-multiplexed systems because the microprocessor and demultiplexing i.cs together cost more, occupy more board space and have more pins overall.

The 68008 has an asynchronous data bus. The time taken to transfer data to or from a memory or peripheral device via the data bus is variable. The memory or peripheral device signals the processor when it is ready to make the data transfer by use of a special handshake line called data transfer acknowledge (DTACK). The advantage of this asynchronous scheme is that each bus cycle can be fine-tuned to the speed of the particular device being accessed. If the device is rather slow, the processor simply marks time until the device is ready. In this way the 68008 runs at the fastest rate that memory and peripherals can go, which maximizes system throughput.

Most M68000-family peripherals have a pin for the DTACK handshake signal, and interfacing such parts to the 68008 microprocessor is simple. Even those peripherals originally designed to work with synchronous processors, like the 6800 or 6809 microprocessor units, may be interfaced to the 68008 with minimal hardware. This is because the 68008 has several signal pins specially for this purpose. By use of these signals, the M6800-type peripheral device signals the processor to perform the current bus cycle synchronously, making the 68008 behave like a synchronous microprocessor for this one bus cycle.

The 68008 m.p.u. uses a two-line bus arbitration scheme which enables the data bus to be shared efficiently with other microprocessors unitss in a multiprocessor system and with other bus masters such as d.m.a. controllers.

To be continued with interfacing details.

Table 2. 68008 addressing modes

Mode	Generation
Register direct addressing	
Data register direct	$EA=D_n$
Address register direct	$EA=A_n$
Absolute data addressing	
Absolute short	EA=(next word)
Absolute long	EA=(next two words)
Program counter relative addressing	
Relative with offset	$EA=(PC)+d_{16}$
Relative with index and offset	$EA=(PC)+(X_n)+d_8$
Register indirect addressing	
Register indirect	$EA=(A_n)$
Postincrement register indirect	$EA=(A_n)$, $A_n \leftarrow A_n+N$
Predecrement register indirect	$A_n \leftarrow A_n-N$, $EA=(A_n)$
Register indirect with offset	$EA=(A_n)+d_{16}$
Indexed register indirect with offset	$EA=(A_n)+(X_n)+d_8$
Immediate data addressing	
Immediate	Data=next word(s)
Quick immediate	Inherent data
Implied addressing	
Implied register	EA=SR, USP, SP, PC

EA effective address
A_n address register
D_n data register
X_n address or data register used as index register
SR status register PC program counter
d_8 eight-bit offset (displacement)
d_{16} sixteen-bit offset (displacement)
N=1 for byte 2 for words and 4 for long words
( ) contents of
← replaces

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16-line p.a.b.x with options

Hints on construction complete Jaap Kuiper's description of a versatile electronic/electromechanical exchange

Current passing through the telephones has to be kept within acceptable limits. Having used 700Ω relays throughout the O relay requires a 470Ω, 1W series resistor (at 45V supply). As relays O, G, II, EI and R are all controlled from the individual stations they must switch positively. Typical values for limiting resistors turned out to be 390Ω, 1W for II, EI and R, and 1kΩ, 1W for G relays and others working off the 45V supply. Relays using the 12V rail don't need series resistors and so operate economically and reliably. The limiting resistor for G relays, if required fits between the G-bus and contacts gh_2/gi_2 in the external control section.

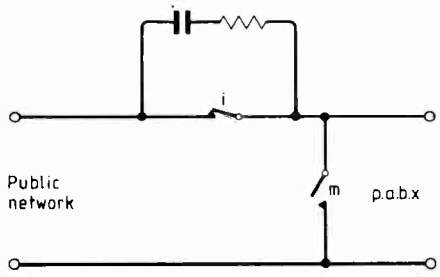
Most Continental telephones include a ground key but where not, momentary push-buttons may be fitted and connected directly to the set's a-line. The original switches, if available, may be fitted in the space provided on top of UK sets in front of the cradle. Holes for the leds have to be drilled or melted in a suitable position and are also connected directly to the a-line. Previous diagrams gave details for both Continental and UK sets.

Special mounting plates (RS Components RS349-119) are available for fitting Siemens/Varley type relays. Each plate holds six relays. Joining these plates together allows daisy-chain wiring of the bussed contacts. The mounting plates have each station's O, T and G relays grouped together for ease of wiring with ribbon cables running to the T-drivers. Terminator, oscillators and line interface were constructed on home-made p.c.bs and 30-way connectors were used to plug in the various telephones.

Resistors in the ground-key toggle have to be approximately the same value as the relay coil and must be capable of dissipating the full power during switching (1kΩ, 5W). The muting i.c. is an LM311 which is rated at 36V maximum, so a voltage divider was included to reduce the supply. These are resistors ra and rb. The reference point is connected through a 1MΩ resistor so as not to affect proper operation of EI which has to follow dial pulses. At 700Ω EI coil value and a telephone presenting 300Ω when operating, the reference voltage will be approximately 31.5V. Therefore divider rc/rd has to be adjusted to provide around 35V. As soon as the dial is moved the reference point goes to the full supply voltage; the 1MΩ resistor protects the i.c. The LM311 will switch up to 40V so the additional transistor was included for protection.

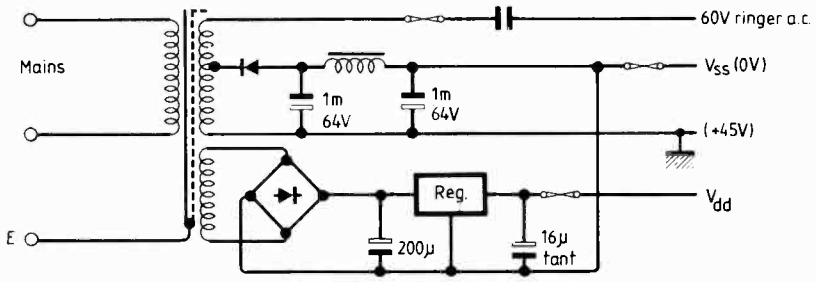
by J. H. Kuiper

With the introduction of more and more d.t.m.f. (system X) exchanges it is sensible to construct the line interface on a separate p.c.b. so that when change-over is required only the line interface needs replacing. A dual tone circuit (Exar application note AN-08) then feeds the 4514 latch. Wiring to the individual sets is by standard four-core cable as each station's b and ground-key wire have to be discrete throughout. This largely applies to the a-wire as well to avoid speech induction to unwanted sets. Led-lines may, however, be joined together at convenient places to reduce the number of leads.



Automatic dialling by computer requires two buffered output ports each driving a relay. Additional hardware requirements are minimal as shown here.

Power supply diagram. Current of the 33V secondary producing 45V direct is 1.5A. Using higher impedance coils will reduce this. Current from the 9V secondary is 100mA; a 12V regulator is used on this supply. The 1μF, 250V ringer-line capacitor is not needed for UK sets.



Born in Friesland in 1949 and having lived in Holland since 1960, Jaap Kuiper completed his study of electrical engineering and electronics at Alkmaar Polytechnic in 1970 after which he worked as a buyer re-exporting equipment to Indonesia and Singapore. Since 1977 he has run a small import/wholesale business specialising in audio accessories and computer peripherals.

The line isolating and matching transformer is available from RS Components (RS217-826). The RC shunt across the interruptor contact consists of a 1μF, 250V capacitor and a 560Ω, 1W resistor on the Continent and 2μF, 250V and 600Ω, 1W in the UK. In view of interface requirements relays EI and M should be new types as they must have a contact bounce of less than 4ms and contact resistance of less than 200mΩ. All other relays may be surplus types. Diodes are general-purpose high-speed silicon types. Many diodes used combine or separate switching actions to reduce the number of relay contacts; these are rated at 100mA (BA155). Diodes used in the oscillator circuits and sections working at 12V may be rated lower.

Note that in stations not requiring the muting-inhibit action the g_4 contact becomes redundant. Since relays usually come with two or four contacts, a component can be reduced by omitting the diode between contact t_2 and the G coil and connecting spare contact g_4 directly from t_2 to ground (marked with asterisk on page 63 of November issue).

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NEW PRODUCTS

WW 305

Micro-floppy

Following other Japanese manufacturers, Teac have announced the availability of FD-30A, a 3in floppy disc drive that has all the same characteristics as their 5.25in drives; capacity, format, density, disc rotation speed, transfer rate and power and data interface connections are all identical. This makes it fully compatible and a direct replacement for its larger cousin. With a brushless d.c. direct-drive motor, the drive is claimed to be very durable and electrical noise is eliminated. Available in the UK through Tekdata Electronics, Federation Road, Burslem, Stoke-on-Trent ST6 4HY.
WW 305

Transistor tester

An addition to their range of hand-held test units is the Osgorne 4500 transistor tester. Completely self-contained, it can be used easily to check p-n junctions of discrete semiconductors whether in or out of circuit. It features a series of leds which indicate the junction status; p-n-p or n-p-n, open or short circuit can be instantly identified and it will work reliably even when parallel circuits have values approaching 270 ohms or 33 microfarads. Osborne Electronics, Binstead Road, Ryde, Isle-of-Wight.
WW 306

Voice digitizer

A voice digitizer may be used to enable the transmission of voice and data down the same telephone line. An American model, the Switchco TSP series 1000 works at a very low data rate of 2400bit/s which makes it easy to use with data modems or, by using a multi-port modem it can transmit four voice conversations over the same line. It is distributed by Vanderhoff Communications Ltd, Haunchwood Estate, Bermuda Road, Nuneaton, Warwicks CV10 7QF.
WW 307

Conduct heat —not current

Another American product is a thermally-conductive dry filled silicone rubber that provides 2000V isolation between power semiconductors and heat sinks. The low-cost Aarvid Rubber-Duc pads are vulcanised onto the heatsinks in the factory and eliminate mica washers and grease or silicone rubber pads and adhesives, while offering better thermal conductivity than either. Configurations suitable for TO-3, TO-66 and plastic power devices as well as DO-4 and DO-5 diode washers. Warth International Ltd, Oxted, Surrey.
WW 308

Shaft cutter

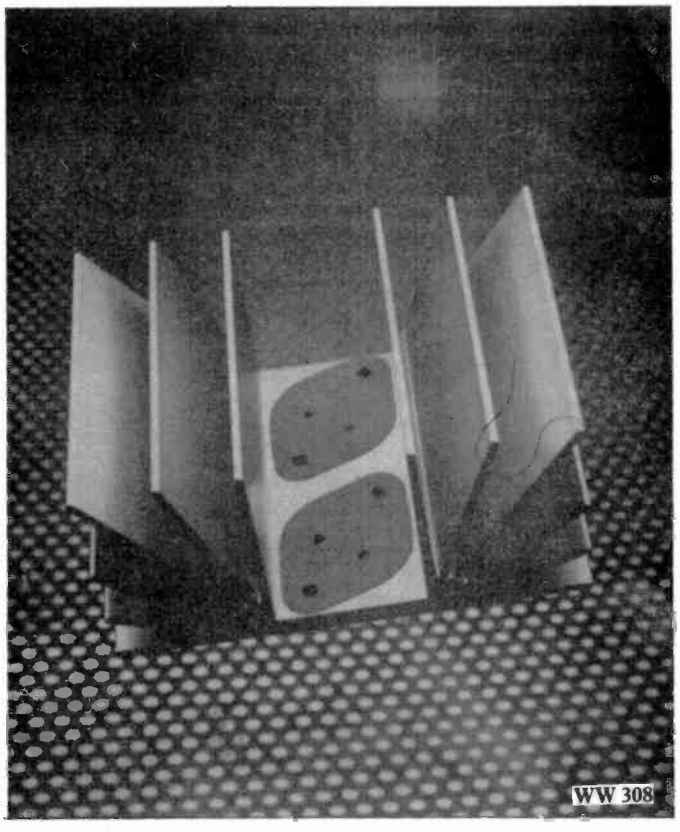
The cutting of shafts on potentiometers, rotary switches and variable capacitors has been made much easier by the introduction of the Telpro shaft shear. This guillotine-type tool will cut copper, aluminium, mild and stainless steel, and plastics rods of diameters up to 0.25in or 6mm. It does not transmit any shock or vibration and may be used on such delicate components as helical trimmers, providing a clean cut with no need for further filiing or finishing. It is claimed that the tool will pay for itself by cutting as few as half-a-dozen shafts because of the reduction in time and damage to components. Electronic and Computer Workshop Ltd., 171 Broomfield Road, Chelmsford, Essex CM1 1RY.
WW 309

Laser for communication

A new high-frequency GaAlAs diode laser with a modulation bandwidth of 6GHz is mounted in an impedance matched high frequency module which includes an integral power-monitoring photodiode for the automatic control of carrier wave output power. The laser diode can be used for the transmission of analogue or digital signals from d.c. up to microwave frequencies over long or short optical links. For a complete high-speed link, there is a matching photodiode with a 7GHz detection bandwidth. The small size, light weight and very low power consumption of the laser make it suitable for airborne or remotely powered system use. Typical applications include multi-channel communications, phased array antennae, or radar signal transmission. Walmore Electronics Ltd, 11 Betterton Street, London WC2H 9BS. **WW 310**

Polyester capacitors

An alternative to the multi-layered ceramic capacitor in decoupling application is offered by the Suflex range of metallized polyester capacitors. The SUF168 is a sub-miniature device that allows for high packing density and is printed on the top to allow identification of values when closely mounted. Values range from 1000pF to 1μF with ratings of 50, 60 and 100V d.c. Suflex Ltd, Risca, Newport, Gwent NP1 6YD. **WW 311**



WW 308

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Sinclair goes into business

No modesty has been exercised by Sinclair Research in the naming of their latest computer which they have called the QL for Quantum Leap. It certainly is a leap into an entirely different world from that occupied by the ZX81 or the Spectrum. The QL is being promoted as a purely business machine and is provided with four business-oriented software packages; a word processor, a database, a spreadsheet and a graphics program for the production of graphs and charts. The computer is based on Motorola MC68000 processor which Sinclair claim is a 32-bit processor. The 68000 has 32-bit internal architecture but uses 16-bits externally and the 68008 version used in the QL has an 8-bit data bus. So it's really an 8/16/32-bit processor depending from where you look at it. A second processor, Intel 8049, is used to control the keyboard, generate the sound and act as an RS232C receiver. QL has 128K of ram and there will be a 0.5Mbyte plug-in ram module as an optional extra. Program storage is on Sinclair Microdrive, a tape cartridge medium with 100Kbytes of storage on each of the two built-in drives. There is an expansion slot for up to six further drives.

Sinclair have designed their own operating system, called QDOS, although no discs are involved. QDOS is a single user, multi-tasking system which has the ability to run several programmes concurrently and to display the result simultaneously in different windows on the screen. The operating system uses a new version of Sinclair Basic, called SuperBasic, which is claimed to be so superior to 'normal' Basic as to constitute a different language. It has the ability to define procedures written in individual blocks. A 'constant execution speed' is claimed, that does not get slower if a program is longer.

The computer has a full typewriter-pitch keyboard with 'real' keys, 65 of them, including cursor-control keys and five programmable function keys.

The display facilities are from a wide choice of character sets with a normal format of 84 columns by 25 lines. Two modes of high-resolution graphics are offered; 512 by 256 pixels with four-colour (red, green, black and white) display, and 256 by 256 with an eight-colour display. A 'stipple' command allows the mixing of foreground and background colours to add to the palette. In both modes a varying grey scale is produced on a monochrome monitor. The quality of the display is such that a high-resolution monitor is necessary to take full advantage of the system. Much would be lost by using a tv receiver even though a tv modulated output is provided.

WW 301

A number of interfaces are built in; two RS232C interfaces, two analogue joystick ports, a rom-cartridge slot, a u.h.f modulated tv output as well as an RGB monitor output. There is a general-purpose expansion slot which may be used to plug in a ram module, or other peripherals as they become available. There are also two local area network ports and up to 64QLs and/or ZX Spectrums may be daisy-chained together sharing such facilities as a printer or a data base. Data may be transmitted along the QLAN at 100K baud and there is a handshake protocol to ensure that a receiver station is 'listening'.

The QL is due to be issued to customers toward the end of February. As is usual with Sinclair new products, it will be available on mail-order only and may appear in retail shop after about six months. There is a £7.95 charge for postage and packing and users are invited to join a users' group or QLUB, for an additional £35 a year. Members will get software up-dates and news of all additions.

Planned enhancements already under development include a C comiler, 6800 assembler, emulation of a main-frame terminal, a-to-d converter, a hard disc interface, a modem, a parallel printer interface, and an IEEE-488 interface.

Sinclair Research Ltd, Computer Division, Stanhope Road, Camberley, Surrey GU15 3PS.

WW 301

Wren for £1,000

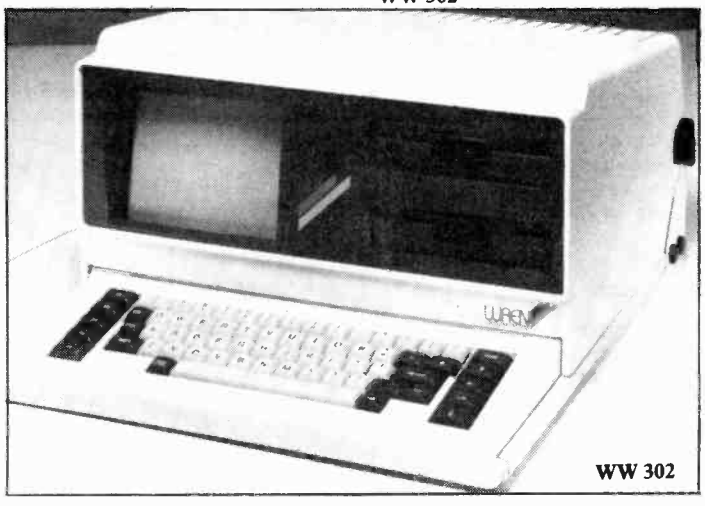
Designed by Transam for Prism Business Systems, the Wren computer is based around a Z80B processor running at 6MHz. It has 64K or ram exandable to 256K, with a diagnostics rom of 8K. A real-time clock is included as is a 50byte c.mos ram, both with battery back-up. It includes a 7in monochrome amber display c.r.t with 36K of screen memory, three selectable screen formats; 80 columns by 24 lines, 40 columns by 24 lines Prestel format, or 512 by 256 elements high-resolution graphics. Although the internal display is monochrome, full colour graphics are supported and there is an RGB output to a colour monitor. The keyboard, which is not detachable, has 67 full size qwerty keys with separate cursor keys and five function keys which allow up to 15 different programmable operations. Two 5.25in disc drives are included with 200Kbyte storage for each drive.

There are a number of interfaces; an RS232 serial port, a Centronics parallel printer port, two analogue inputs for paddle cursor controls, a hard disc interface, and a built in autodial modem which is Prestel and CCITT compatible. Software may be downloaded from Micronet 800 through the inbuilt download facility. For transport, the screen and disc drives in the upper section slide forward over the keyboard, revealing a sturdy carrying handle at the back, it weighs "under 20 lb" (9kg).

The software includes a Z80 version of BBC Basic, a desk-top facility which includes a diary, an address file, a system for creating simple documents such as memos, or expense forms, a filing system, a calculator and it may be used in conjunction with a printer as a typewriter. Perfect Writer, Perfect Calc and Perfect Filer are included along with CP/M 3.

Prism Business Systems Ltd, 18 Mora Street, London EC1V 8BT.

WW 302



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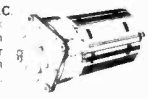

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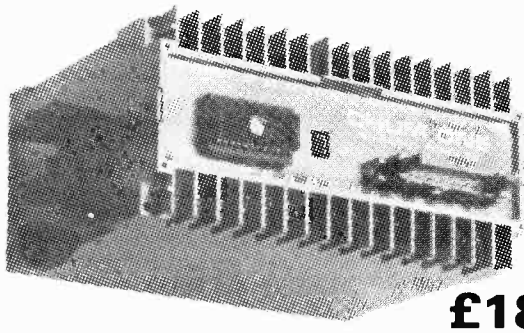

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0.11 μF	250V		100 sent for £5.50 + £1 P&P (£7.48 inc. VAT)
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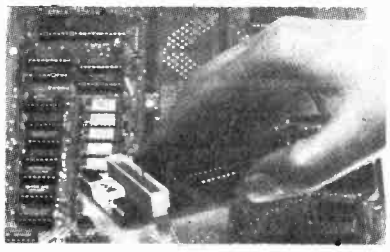

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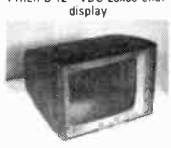

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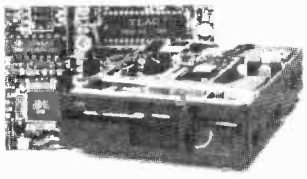

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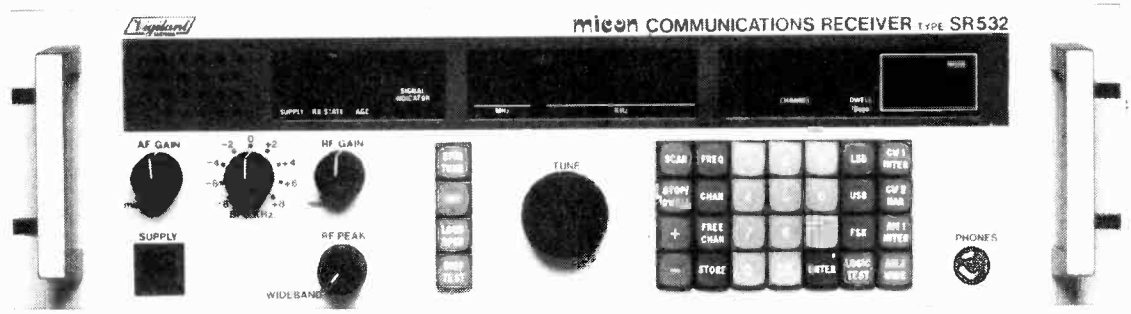

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Increments : 10 Hz or 100 Hz Steps
Stability : ± 1 Part in 10^7/°C
Tuning : Keypad and Spin Wheel
Power Supplies : 110/240V AC and 24V DC
FULLY MODULAR 'PLUG IN' CONSTRUCTION

Memory : 200 Channels Freq/Mode/Filter
Scanning : Full memory or discreet parts
Automatic or Manual Stop
Manual step on or Reverse
Dwell : Variable from Keypad 1 to 9 seconds
KEYPAD FUNCTIONS INDICATED BY DISPLAYS

NOW AVAILABLE AT HIGHLY COMPETITIVE PRICES

Send for Technical Brochure to:
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Tel: (0344) 885656
Telex: 849769 Vigcom G

WW – 016 FOR FURTHER DETAILS

HOME CONTROL CENTRE

This kit enables you to control up to 16 different appliances by means of coded pulses in the mains wiring which may be decoded by special receivers anywhere in the house. The transmitter may be controlled manually or by the computer interface enabling your favourite micro to make your coffee in the morning, switch lights anywhere in the house, or your electric blanket in your bedroom. Just think of the possibilities – and no wiring!
The Kit comprises a transmitter with pre-drilled box and two receivers. XK112 £42.00

XK111 (additional receivers) £10

REMOTE CONTROL KITS

FOR A DETAILED BOOKLET ON REMOTE CONTROL – send 30p × 6" × 9" S.A.E

These kits have been designed to enable infra red remote control to be incorporated into virtually any application from switching car locks or alarms to controlling Hi-Fi or TV. The exact application will determine the interface circuitry (not supplied) between the receiver and the device to be controlled. In many cases this could by a relay or triac. General instructions and applications are supplied with the kits. The kits are coded and provide a high degree of noise immunity and security.

MK18 Transmitter Kit. For use with MK11 MK12 Receivers and MK9 10 13 keyboards. Requires PP3 battery. Size 8 × 2 × 1.3 cms. Range approximately 60ft £6.80
MK11 Receiver Kit. Mains powered. Provides 10 latched plus 3 analogue outputs. Ideal for controlling audio amplifiers, TV or lighting circuits where control of lamp brightness is required £13.50
MK12 Transmitter Keyboard £4.35
MK19 DC Controlled Stereo Amplifier Kit. If control of stereo amplifier is required the MK19 may be used providing for remote control of base, treble and volume (or balance). This kit also includes a one of 10 decoder with LEDs for remote selection of programme or channel. May be connected between the pre-amp and power amp sections of almost any audio amplifier £10.70

MK12 Receiver Kit
MK12 (state latched or momentary) £13.50
MK9 4-way Transmitter Keyboard £1.90
MK10 16-way Transmitter Keyboard £5.40
MK15 Dual Latched Solid State Relay £4.50

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Now you can run your central heating, lighting, hi-fi system and lots more with just one programmable timer. At your selection it is designed to control four mains outputs independently, switching on and off at pre-set times over a seven day cycle, e.g. to control your central heating (including different switching times for weekends), just connect it to your system programme and set and forget it – the clock will do the rest £39.00

XK 114 OPTIONAL RELAY KIT £3.90

Kit includes one relay PCB to accommodate up to four relays, terminal blocks etc. to fit inside CT6000 box. Provides up to four 3amp 240V changeover contacts.
Additional relays £1.65 each

Add 65p postage & packing +15% VAT to total
Overseas Customers
Add £2.50 (Europe), £6.00 (elsewhere) for p&p
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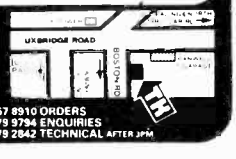

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METAL FILM RESISTORS

100R	1k	10k	100k
110R	1k1	11k	110k
120R	1k2	12k	120k
130R	1k3	13k	130k
150R	1k5	15k	150k
160R	1k6	16k	160k
180R	1k8	18k	180k
200R	2k	20k	200k
220R	2k2	22k	220k
240R	2k4	24k	240k
270R	2k7	27k	270k
300R	3k	30k	–
330R	3k3	33k	330k
360R	3k6	36k	–
390R	3k9	39k	–
430R	4k3	43k	–
470R	4k7	47k	470k
510R	5k1	51k	–
560R	5k6	56k	560k
620R	6k2	62k	–
680R	6k8	68k	680k
750R	7k5	75k	–
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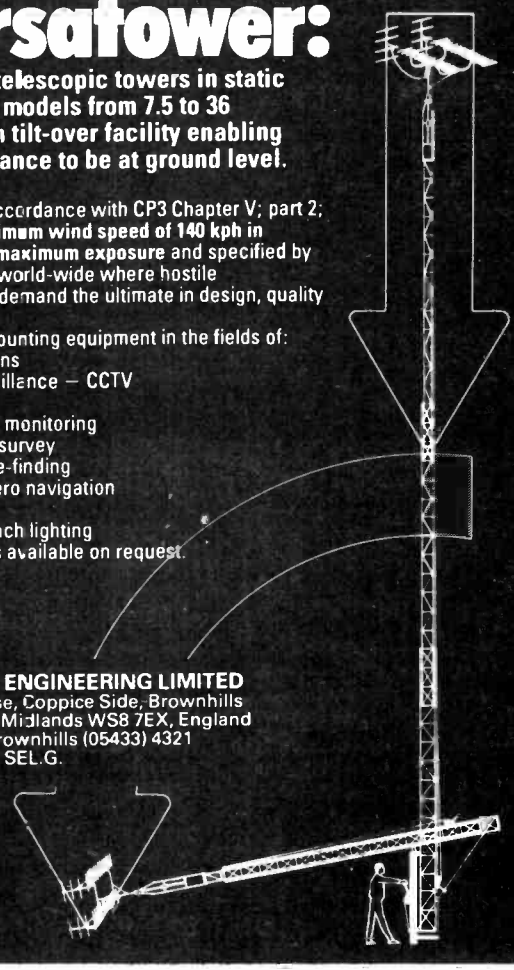

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Telex: 335243 SEL.G.

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200	15.69	2.25
250	18.97	2.64
350	23.47	2.70
500	29.23	2.95
750	41.28	3.70
1000	53.00	4.00
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2000	82.27	5.10
3000	115.35	OA
6000	203.65	OA

*115 or 240V sec only.

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400/440 to 200/240V CT

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500	29.23	2.95
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3000	115.37	OA
6000	228.75	OA

12/24V or 12-0-12V
2×12V Secs. Pri. 240V

12V	24V	Price	P&P
.3A	.15	2.41	.90
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2	1	4.25	1.20
4	2	4.91	1.60
6	3	7.69	1.60
8	4	8.98	1.60
10	5	9.82	1.80
12	6	10.89	1.90
16	8	12.97	2.12
20	10	17.46	2.44
30	15	21.69	2.64
60	30	44.45	OA
83	41	51.20	4.50

96/48V. Pri 2×120V
Secs 2×36/48V

72/96V	36/48V	Price	P&P
.5A	1	5.37	1.20
2	4	14.69	2.20
3	6	17.79	2.40
5	10	32.23	3.20
6	12	40.36	3.50
8	16	44.03	3.75

50/25V or 25-0-25V
2×25V Tap secs. Volts 5, 7, 8, 10, 13, 15, 17, 20, 25, 30, 33, 40, 20-0-20 or 25 0-25V

50V	25V	Price	P&P
.5	1	4.13	1.40
2	4	8.69	1.84
3	6	10.36	1.90
4	8	14.10	2.12
6	12	18.01	2.20
8	16	24.52	2.70
10	20	30.23	3.00
12	24	36.18	3.20

60/30V or 30-0-30V
Pri 2x120V. 2×30V Tap Secs Volts 6, 8, 10, 12, 16, 18, 20, 24, 30, 36, 40, 48, 60, 24-0-24 or 30-0-30V.

60V	30V	Price	P&P
.5	1	4.70	1.50
1	2	7.15	1.50
2	4	9.20	1.90
3	6	13.31	2.00
4	8	15.15	2.20
5	10	19.16	2.20
6	12	21.86	2.65
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10	20	35.76	3.30
12	24	41.22	3.50

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3-0-3	.2A	3.11	.90
6×2	1A×2	3.45	1.20
9-0-9	.1	2.59	.90
9×2	.33×2	2.41	.90
8,9×2	.5×2	3.36	1.20
8,9×2	1A×2	4.27	1.40
15×2	.2A×2	2.41	.90
12-0-12	.05	3.11	.90
20×2	.3×2	3.39	1.20
20,12,0			
12,20	.7(DC)	4.13	1.20
15,20-2	1A×2	5.60	1.60
15,27×2	.5×2	4.83	1.40
15,27×2	1A×2	7.30	1.60

30/15V or 15-0-15V
2×15V tap Sec. Volts 3, 4, 5, 6, 8, 9, 10, 12, 15, 18, 20, 24, 30 or 15-0-15V

30V	15V	Price	P&P
.5A	1	3.19	1.20
1	2	4.32	1.40
2	4	6.99	1.60
3	6	8.10	1.85
4	8	9.67	1.90
5	10	11.95	2.00
6	12	13.52	2.00
8	16	18.10	2.26
10	20	20.88	2.26
12	24	23.20	2.50
15	30	26.60	3.00
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105, 115, 220, 230, 240V
For step-up or down

VA	Price	P&P
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150	6.48	1.60
350	11.84	2.00
500	13.30	2.24
1000	22.70	2.80
1500	28.17	3.20
2000	42.14	4.00
3000	71.64	4.80
5000	108.30	OA

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500	22.14	2.20
1000	33.74	2.80
2000	60.47	4.50

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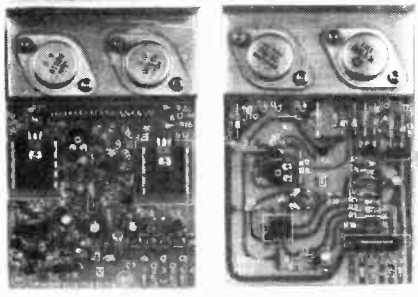

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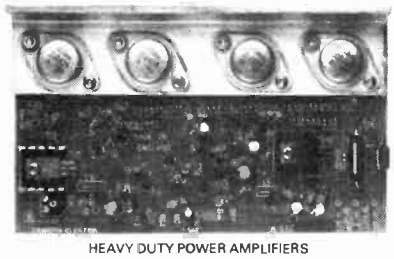

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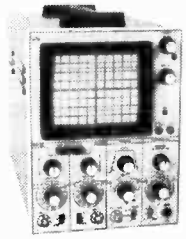

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MC1307P	1.00	SN76227N	1.05	TBA395	1.50	TDA1035	2.50
MC1310P	1.50	SN76533N	1.65	TBA396	0.75	TDA1037	1.95
MC1327	0.96	SN76544N	1.95	TBA440N	2.55	TDA1170	1.95
MC1327Q	0.95	SN76570N	1.00	TBA480Q	1.25	TDA1190	2.15
MC1330P	0.78	SN76650N	1.15	TBA510	2.50	TDA1270Q	3.95
MC1349P	1.20			TBA510Q	2.50	TDA1327	1.70
				TBA520	1.10	TDA2002	1.95
				TBA520Q	1.10	TDA2020	2.45

TDA2030	2.80	UPC1156H	1.75	555	0.35		
TDA2522	1.95	UPC1158H	0.75	556	0.42		
TDA2523	1.95	UPC1167C	1.15	723	0.50		
TDA2524	1.95	UPC1181H	1.25	741	0.35		
TDA2530	1.95	UPC1182H	2.95	747	0.50		
TDA2532	1.95	UPC1185H	3.95	748	0.35		
TDA2540	1.25	UPC1191V	1.50	7805	0.60		
TDA2541	2.15	UPC1350C	2.95				
TDA2560	2.15	UPC1353C	2.45				
TDA2571	1.95	UPC1365C	3.95				
TDA2581	2.25	UPC2002H	1.95				
TDA2593	2.95						
TDA2600	5.50						
TDA2610	2.50						
TDA2611A	1.95						
TDA2640	2.60						
TDA2680A	2.75						
TDA2690	2.45						
TDA3560	5.50						
UPC566H	2.95						
UPC575C2	2.75						
UPC1025H	2.50						
UPC1028H	1.95						
UPC1032H	1.50						

SEMICONDUCTORS

AAY12	0.25	BC174	0.09	BD202	0.85	BF457	0.32
AC126	0.22	BC174A	0.09	BD203	0.78	BF458	0.36
AC127	0.20	BC177	0.15	BD204	0.70	BF459	0.36
AC128	0.28	BC178	0.15	BD222	0.48	BF595	0.23
AC128K	0.32	BC182	0.10	BD223	0.48	BF597	0.25
AC141	0.28	BC182LB	0.10	BD225	0.48	BFR39	0.23
AC141K	0.34	BC183	0.10	BD232	0.35	BFR40	0.23
AC142K	0.30	BC183L	0.09	BD233	0.35	BFR41	0.28
AC176	0.22	BC184LB	0.09	BD234	0.35	BFR81	0.25
AC176K	0.31	BC204	0.10	BD236	0.45	BFR88	0.30
AC178	0.28	BC207B	0.13	BD237	0.40	BFR90	1.50
AC187	0.25	BC208B	0.13	BD238	0.40	BFR91	1.75
AC187K	0.28	BC212	0.09	BD241	0.40	BFT42	0.28
AC188	0.25	BC212L	0.09	BD242	0.50	BFT43	0.28
AC188K	0.37	BC212LA	0.09	BD246	0.60	BFW92	0.85
AD142	0.79	BC213	0.09	BD376	0.32	BFX29	0.30
AD143	0.82	BC213L	0.09	BD410	0.55	BFX84	0.26
AD149	0.70	BC214	0.09	BD434	0.55	BFX85	0.32
AD161	0.39	BC214C	0.09	BD437	0.50	BFX86	0.30
AD162	0.39	BC214L	0.09	BD438	0.60	BFX88	0.25
AD161/2	0.90	BC237B	0.09	BD506	0.50	BFY50	0.21
AF114	1.50	BC238	0.09	BD508	0.40	BFY51	0.21
AF124	0.34	BC239	0.12	BD520	0.65	BFY52	0.26
AF125	0.35	BC251A	0.12	BD538	0.65	BFY90	0.77
AF126	0.32	BC252A	0.15	BD539	0.75	BLY48	1.75
AF127	0.32	BC258	0.25	BD697	1.10	BR100	0.28
AF139	0.40	BC258A	0.39	BD698	1.10	BR101	0.30
AF178	1.95	BC284	0.30	BD707	0.80	BRC4443	0.85
AF239	0.42	BC300	0.30	BDX32	1.50	BT106	1.49
AU106	2.00	BC301	0.30	BDY57	1.65	BT108	1.89
AU110	2.00	BC303	0.26	BF115	0.35	BT116	1.20
AU113	2.95	BC307	0.09	BF127	0.24	BT119	1.65
BC107A	0.11	BC307A	0.09	BF154	0.12	BT120	1.65
BC107B	0.11	BC307B	0.09	BF158	0.22	BU105	1.22
BC108	0.10	BC327	0.10	BF160	0.27	BU108	1.69
BC108A	0.11	BC328	0.10	BF167	0.24	BU124	1.25
BC108B	0.12	BC337	0.10	BF173	0.22	BU125	£1.25
BC109	0.10	BC338	0.09	BF177	0.38	BU126	1.60
BC109B	0.12	BC347A	0.13	BF178	0.26	BU204	1.55
BC109C	0.12	BC461	0.35	BF179	0.34	BU205	1.30
BC114	0.11	BC478	0.20	BF180	0.29	BU208	1.39
BC116A	0.15	BC527	0.20	BF181	0.29	BU208A	1.52
BC117	0.19	BC547	0.10	BF182	0.29	BU326	1.20
BC119	0.24	BC548	0.10	BF183	0.29	BU407	1.24
BC125	0.25	BC549A	0.08	BF184	0.28	BU500	2.25
BC139	0.20	BC550	0.08	BF185	0.28	BU526	1.90
BC140	0.31	BC557	0.08	BF194	0.11	BUY69B	1.70
BC141	0.25	BC557B	0.08	BF195	0.11	MJ3000	1.98
BC142	0.21	BC558	0.10	BF196	0.11	MJE340	0.40
BC143	0.24	BCY33A	1.60	BF197	0.11	MJE520	0.48
BC147	0.09	BD115	0.30	BF198	0.16	MPSA12	0.20
BC147B	0.09	BD116	0.60	BF199	0.14	MPSA13	0.20
BC148A	0.09	BD124P	0.59	BF200	0.40	MPSA92	0.30
BC148B	0.09	BD131	0.32	BF241	0.15	MRF450A	12.50
BC149	0.09	BD132	0.35	BF245	0.30	MRF453	17.50
BC157	0.12	BD133	0.40	BF256/LC	0.28	MRF454	23.50
BC158	0.09	BD135	0.30	BF257	0.28	MRF475	2.50
BC159	0.09	BD136	0.30	BF258	0.28	MRF477	10.00
BC160	0.28	BD137	0.32	BF259	0.28	OC23	1.50
BC161	0.28	BD138	0.30	BF271	0.26	OC42	0.55
BC170B	0.15	BD139	0.32	BF273	0.13	OC44	0.75
BC171	0.09	BD140	0.30	BF336	0.34	OC45	0.55
BC171A	0.10	BD144	1.10	BF337	0.29	OC70	0.45
BC171B	0.10	BD159	0.65	BF338	0.32	OC71	0.40
BC172	0.10	BD166	0.55	BF355	0.37	OC81	0.50
BC172B	0.10	BD179	0.72	BF362	0.38	R2008B	1.70
BC172C	0.10	BD182	0.70	BF363	0.38	R2010B	1.70
BC173B	0.10	BD201	0.83	BF371	0.20	R2322	0.58
				BF394	0.19	R2323	0.66
				BF422	0.32	R2540	2.48

RCA16334	0.90						
RCA16335	0.80						
SKE5F	1.45						
TIP29	0.40						
TIP29C	0.42						
TIP30C	0.43						
TIP31C	0.42						
TIP32C	0.42						
TIP33B	0.75						
TIP34B	0.75						
TIP41A	0.46						
TIP41C	0.46						
TIP42C	0.47						
TIP47	0.65						
TIP120	0.60						
TIP125	0.65						
TIP142	1.75						
TIP146	2.75						
TIP161	2.95						
TIP2955	0.80						
TIP3055	0.55						
TIS91	0.20						
TV106/2	1.50						
2N2219	0.28						
2N2905	0.40						
2N3053	0.40						
2N3054	0.59						
2N3055	0.52						
2N3702	0.12						
2N3703	0.12						
2N3704	0.12						
2N3705	0.12						
2N3706	0.12						
2N3708	0.12						
2N3773	1.95						
2N3792	1.35						
2N4427	1.50						
2N4444	1.15						
2N5294	0.42						
2N5296	0.48						
2N5298	0.60						
2N5496	0.65						
2SA715	0.60						
2SC495	0.80						
2SC496	0.80						
2SC1096	0.80						
2SC1106	2.50						
2SC1172Y	2.20						
2SC1173	1.15						
2SC1306	1.00						
2SC1307	1.50						
2SC1449	0.80						
2SC1678	1.25						
2SC1909	1.95						
2SC1945	2.10						
2SC1953	0.95						
2SC1957	0.80						
2SC1969	1.95						
2SC2028	1.15						
2SC2029	1.96						
2SC2078	1.45						
2SC2091	0.85						
2SC2098	2.50						
2SC2166	1.95						
2SC2314	0.80						
2SD234	0.50						
3N211	1.95						
3SK45	0.70						
3SK88	0.55						

DIODES

AA119	0.08	BY199	0.40	IN4004	0.05
BA102	0.17	BY206	0.14	IN4005	0.06
BA115	0.13	BY208-800	0.33	IN4006	0.06
BA145	0.16	BY210-800	0.33	IN4007	0.06
BA148	0.17	BY223	0.90	IN4148	0.02
BA154	0.06	BY298-400	0.22	IN4448	0.10
BA155	0.13	BY299-800	0.22	IN5401	0.12
BA156	0.15	BYX10	0.20	IN5402	0.14
BA157	0.30	BYX36-150R	0.20	IN5403	0.12
BAX13	0.04	BYX38-600R	0.60	IN5404	0.12
BAX16	0.06	BYX55-600	0.30	IN5405	0.13
BB105B	0.30	BYX71-600	1.10	IN5406	0.13
BT151	0.79	BZY95C30	0.35	IN5407	0.16
BY126	0.10	OA47	0.09	IN5408	0.16
BY127	0.11	OA90	0.05	ITT44	0.04
BY133	0.15	DA91	0.06	ITT923	0.15
BY164	0.45	OA95	0.06	ITT2002	0.10
BY176	1.20	OA202	0.10		
BY179	0.83	IN914	0.04		
BY182	0.55	IN4001	0.04		
BY184	0.35	IN4002	0.04		
		IN4003	0.04		

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A3042	24.00	EBC81	0.85	EL34 Philips	
A3283	24.00	EBC90	0.75		3.15
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AH221	39.00	EBF89	0.70	EL81	6.95
AH238	39.00	EBF93	0.95	EL82	0.58
AL60	6.00	EBL1	2.50	EL84	0.75
ARP12	0.70	EBL21	2.00	EL85	4.50
ARP34	1.25	EC52	0.75	EL86	0.85
ARP35	2.00	EC70	0.75	EL90	1.25
BL63	2.00	EC80	9.50	EL91	6.00
BS450	67.00	EC81	4.50	EL95	0.70
BS810	55.00	EC86	1.00	EL153	12.15
BS814	55.00	EC88	1.00	EL183E	3.50
CIK	16.00	EC90	1.10	EL163P	3.50
C3JA	16.00	EC91	7.00	EL360	7.95
C110	55.00	EC92	1.25	EL500	1.40
C1134	32.00	EC93	0.80	EL504	1.40
C1148A	115.00	EC95	7.00	EL509	5.25
C1149/1	130.00	EC97	1.10	EL519	6.95
C1150/1	135.00	EC8010	6.00	EL802	3.65
C1534	32.00	ECC32	3.00	EL821	8.50
CCA	2.60	ECC33	3.50	EL822	12.95
CC3L	0.90	ECC35	3.50	EM1	9.00
CL33	2.00	ECC40	3.00	EM4	9.00
CV Nos Prices on request		ECC81	1.15	EM35	1.50
D63	1.20	ECC82	0.55	EM80	0.70
DAF91	0.70	ECC83 Brimar/ Mullard	1.35	EM81	0.70
DAF96	0.65	ECC82 Philips		EM84	1.65
DC70	1.75		1.50	EM85	3.95
DC90	1.20	ECC83	0.65	EM87	2.50
DCX4-1000		ECC83 Philips		EN10	8.00
	12.00		1.95	EN32	13.50
DCX4-5000		ECC84	0.50	EN91	1.10
	25.00	ECC85	0.60	EN92	4.50
DET18	28.50	ECC86	2.75	EY51	0.80
DET22	28.00	ECC88	0.85	EY81	1.50
DET24	39.00	ECC91	2.00	EY83	1.50
DET25	22.00	ECC180	0.72	EY84	6.95
DF91	0.70	ECC189	0.78	EY84W	10.00
DF92	0.60	ECC801S	3.50	EY86/87	0.50
DF96	0.65	ECC803S	3.50	EY88	0.55
DF97	1.00	ECC804	0.60	EY91	5.50
DH63	1.20	ECC807	2.50	EY500A	1.50
DH77	0.90	ECC2000	12.00	EY802	0.70
DH79	0.56	ECF80	0.85	EZ35	0.75
DH149	2.00	ECF82	0.85	EZ40	2.15
DK91	0.90	ECF86	1.70	EZ41	2.15
DK92	1.20	ECF200	1.85	EZ80	0.60
DK96	2.50	ECF202	1.85	EZ81	0.60
DL35	1.00	ECF801	0.85	EZ90	0.96
DL63	1.00	ECF804	6.00	F6064	2.95
DL70	2.50	ECF805	2.50	FW4/800	2.00
DL73	2.50	ECF806	10.25	G1/371K	30.00
DL91	1.50	ECH3	2.50	G55/1K	9.00
DL92	0.60	ECH4	3.00	G180/2M	9.00
DL93	1.10	ECH35	1.60	G240/2D	9.00
DL94	2.50	ECH42	1.00	G400/1K	14.00
DL96	2.50	ECH81	0.58	GC10B	17.50
DLS10	13.50	ECH83	0.78	GC10D	17.50
DLS16	10.00	ECH84	0.69	GC10/4B	17.50
DM70	1.10	ECH2000	1.50	GC10/4E	17.50
DM160	2.75	ECL80	0.60	GC12/4B	17.50
DY51	1.00	ECL82	0.65	GD86W	6.00
DY86/87	0.65	ECL83	2.50	GDT120M	5.00
DY802	0.72	ECL84	0.74	GE10	9.00
E80CC	7.00	ECL85	0.69	GN4	6.00
E80CF	10.00	ECL86	0.80	GN10	15.00
E80F	13.50	ECL805	0.69	GR10G	4.00
E80L	11.50	EF37A	2.00	GR10J	4.00
E81CC	3.50	EF39	1.00	GS10C	16.50
E81L	12.00	EF41	3.50	GS10H	12.00
E82CC	3.50	EF42	3.50	GS12D	12.00
E83CC	3.50	EF50	2.50	GT1C	17.00
E83F	5.50	EF55	3.50	GT1C S/S	13.00
E86C	9.50	EF71	1.50	GTE175M	8.00
E88C	7.95	EF72	1.20	GTR150W	1.00
E88CC	3.50	EF73	1.00	GU20	35.00
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E92CC	2.25	EF86	1.25		14.50
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EABC80	0.70	HL41DD	3.50		
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		HL92	1.50		
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		HR2	4.00		
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		KT8C	7.00		
		KT33C	3.50		
		KT36	2.00		
		KT44	4.00		
		KT45	4.00		
		KT63	2.00		
		KT66 USA	7.15		
		KT66 GEC			
			14.95		
		KT77 Gold Lion			
			9.50		
		KT81	7.00		
		KT88 USA	8.00		
		KT88 Gold Lion			
			15.95		
		KTW61	2.00		
		KTW62	2.00		
		KTW63	2.00		
		KTZ63	2.50		
		L63	1.20		
		L102/2K	6.95		
		L120/2K	12.00		
		M502A	95.00		
		M537A	95.00		
		M5143	155.00		
		M8079	6.00		
		M8082	7.50		
		M8083	3.25		
		M8091	7.50		
		M8096	3.00		
		M8098	5.50		
		M8099	5.00		
		M8100	5.50		
		M8136	7.00		
		M8137	5.50		
		M8161	6.50		
		M8162	5.50		
		M8163	5.50		
		M8190	4.50		
		M8195	6.50		
		M8196	5.50		
		M8204	5.50		
		M8223	4.50		
		M8224	2.00		
		M8225	3.50		
		ME1401	29.50		
		ME1402	29.50		
		ME1501	14.00		
		MH4	3.50		
		MHLD6	4.00		
		MS4B	5.50		
		MU14	1.50		
		N37	12.50		
		N78	9.85		
		OA2	0.85		
		OA2WA	1.50		
		OA3	2.50		
		OB2	0.85		
		OB2WA	1.25		
		OC2	2.50		
		OC3	1.50		
		OD3	1.70		
		OM4	1.00		
		OM5B	3.00		
		OM6	1.75		
		OM9	4.00		
		ORP43	2.50		
		ORP50	3.95		
		P61	2.50		
		P41	2.50		
		PABC80	0.50		
		PC86	0.75		
		PC88	0.75		
		PC92	3.50		
		PC97	1.10		
		PC800	1.10		
		PC900	1.25		
		PCC84	0.40		
		PCC85	0.54		
		PCC88	0.70		
		PCC89	0.70		
		PCC189	0.70		
		PCC805	0.70		
		PCC806	0.80		
		PCE82	0.80		
		PCF80	0.65		
		PCF82	0.60		
		PCF84	0.65		
		PCF86	1.20		
		PCF87	0.40		
		PCF200	1.80		
		PCF201	1.80		
		PCF800	0.40		
		PCF801	1.35		
		PCF802	0.60		
		PCF805	1.25		
		PCF806	1.00		
		PCF808	1.25		
		PCH200	1.50		
		PCL82	0.80		
		PCL83	2.50		
		PCL84	0.85		
		PCL85	0.80		
		PCL86	0.85		
		PCL200	1.60		
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		PCL805	0.90		
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		PD510	3.65		
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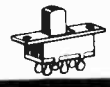

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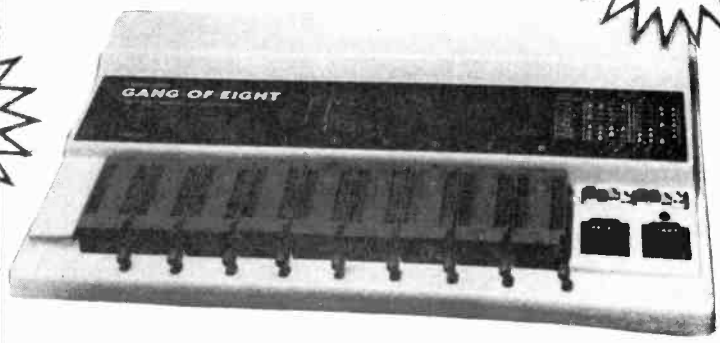

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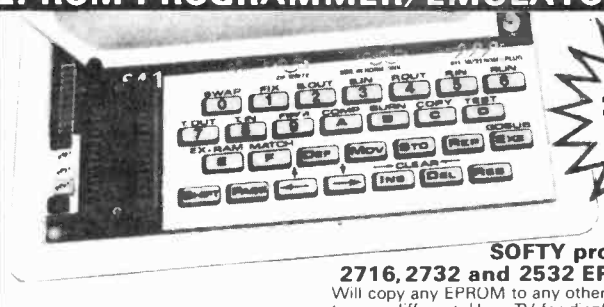

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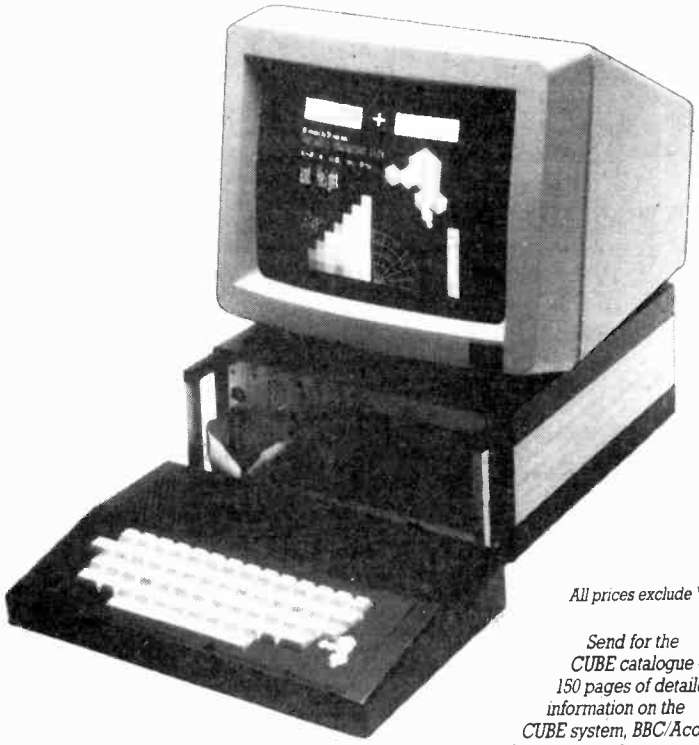

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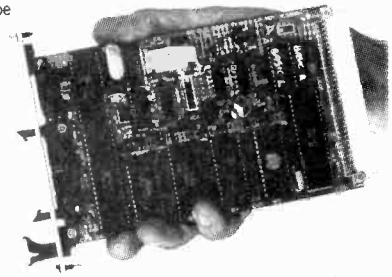

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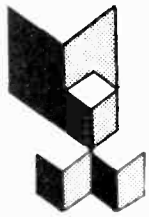

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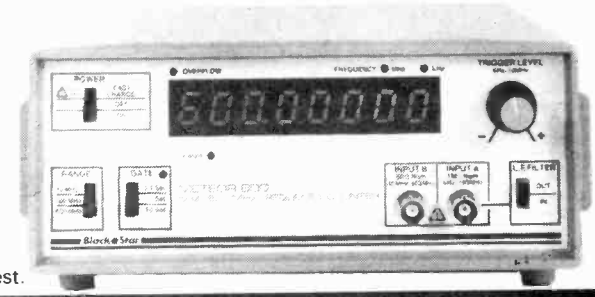

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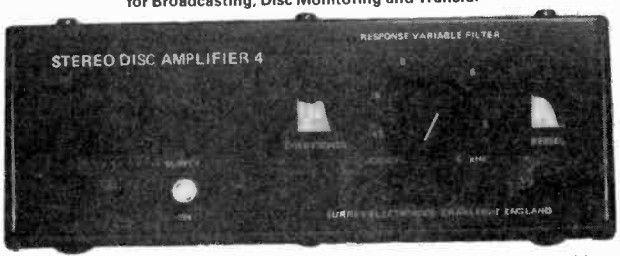

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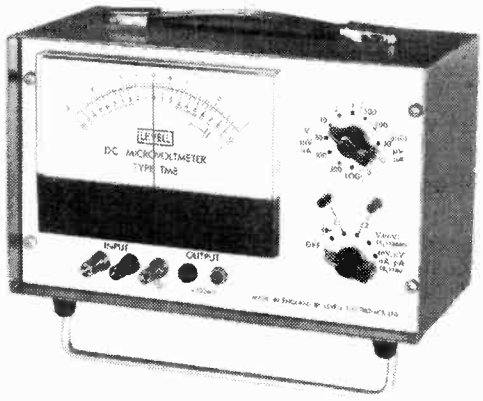

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10-0-10V, 2 amp £4.00 £1	25-0-25V. 2 amp	£5.50 £1
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12V. 100ma £1.50 £1	30V 1½ amp	£5.00 £1
12V. 750 ma £2.50 £1	30V. 5 amp and	
12V. 3 amp £4.50 £1	17-0-17 2a	£5.50 £2
12-0-12V. 2 amp £5.50 £1	35V 2 amp	£5.00 £1

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.1MF 400V **14p**. 600V **15p**. 1000V **25p**.
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20/500V	75p	150+200/275V	50p	32+32/350V	85p
32/350V	45p	32+32+32/450V	95p	32+32/500V	£2
32/500V	95p	50+50+50/350V	95p	50+50/300V	50p
125/500V	£2	8+8/500V	£1	50+50/350V	80p

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GROUP 45	12	4-8-16	45	PA	£16	£2
DG 75	12	4-8-16	75	PA	£20	£2
GROUP 100	12	8-16	100	PA	£26	£2
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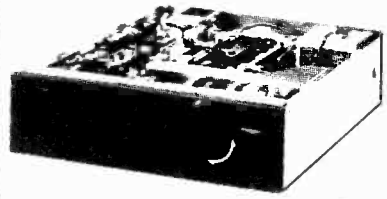

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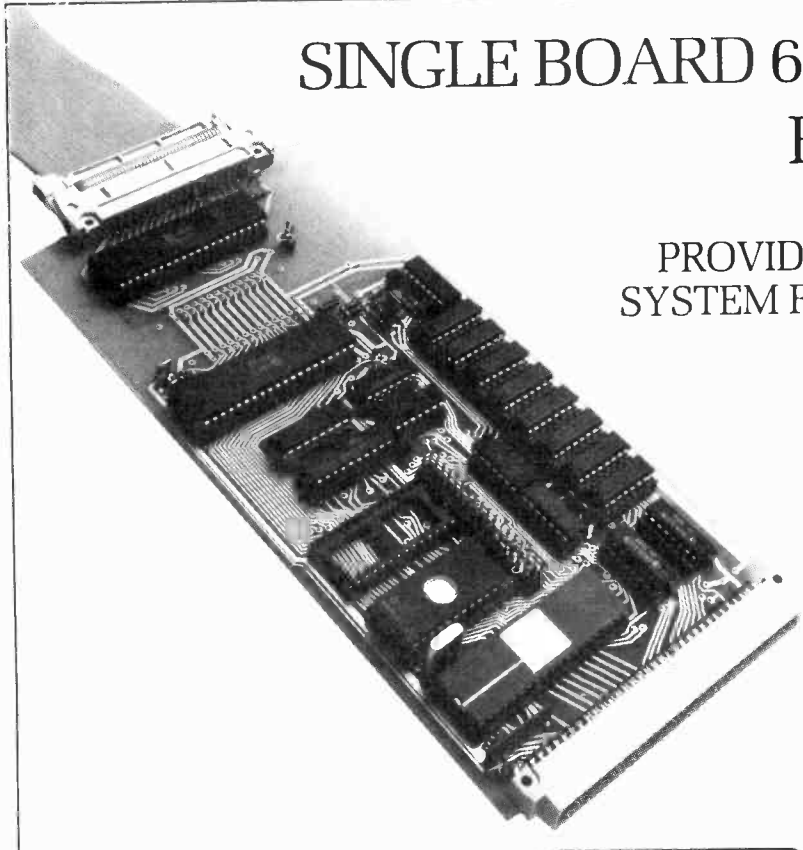

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Send for our questionnaire which, when completed, enables us to post quotations by return.

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Telex 987703G Sowter

WW – 063 FOR FURTHER DETAILS

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FET SYSTEM AMP

Features:
- HIGH POWER up to 1.2kW (single ended)
- LOW VOLUME. 1/15 Cubic foot inc. Heatsink
- VERSATILE. Delivers more than 1kW into ½ to 8 ohms

OR 2 × 600W into 2 to 8Ω
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OR { 1 × 600W into 2 to 8Ω
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Etc., etc.

Having been closely involved in a wide variety of OEM applications of their amp boards. Pantechnic became aware of numerous implementation problems often left untackled by other amp board manufacturers. These problems specifically of size and thermal efficiency became particularly aggravated at high powers and considerably lengthened OEM product development time.
By including thermal design in the totality of board design it has been possible to reduce the size of the electronics, and increase the efficiency of the transistor to heatsink thermal circuit. The combined effect of this has been to dramatically increase the volumetric efficiency of the amplifier/heatsink assembly. The **SYSTEM** Amp offers 1.2kW of power in a space of 180mm x 102mm × 77mm, excluding PSU and Fan.
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The flexibility of the 1.2kW amp stems from its division into 4 potentially separate amplifiers of 300W each (downrateable with cost savings to 150W). These can be paralleled, increasing current capability or seriesed (bridged in pairs) doubling voltage capability. In consequence a large variety of amplifier/load strategies can be implemented
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Tel: 051-428 8485

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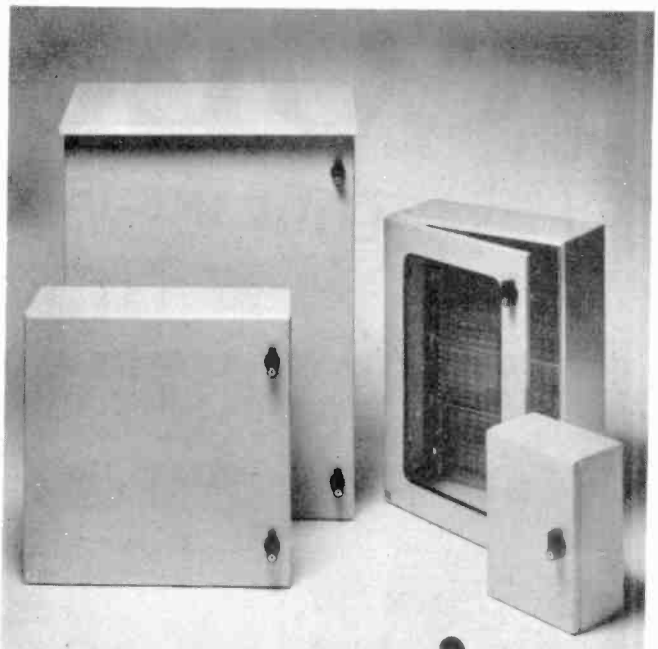

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Company_____

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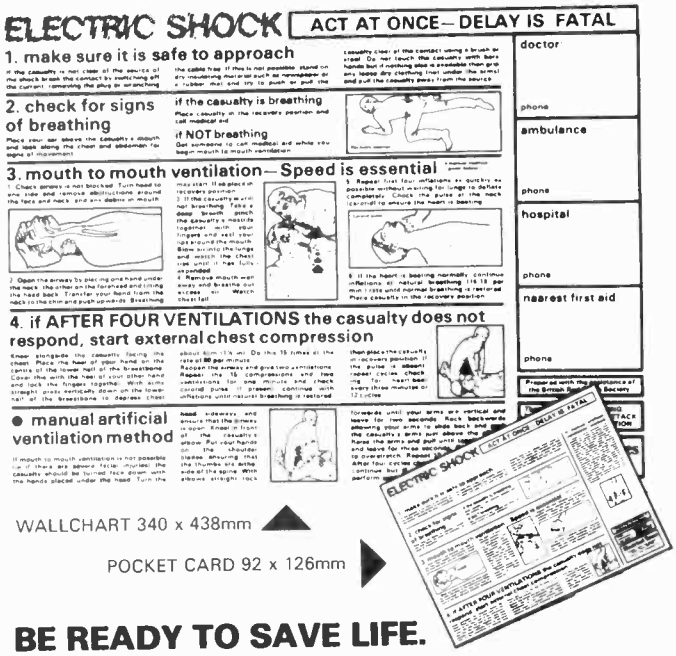

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CARBON FILM 5% HI STAB LOW NOISE
10Ω TO 10MΩ
¼W E24 2p
½W E24 2½p
1W E24 6p
2W E24 12p

METAL FILM ULTRA STABLE
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10Ω TO 1MΩ
2% E24 5p
1% E24 6p

LOW DHMIC GLAZE ½W
0 22Ω to 8 2Ω
E 24 11p

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E 12 SERIES
2 to 3W 0 22Ω to 330Ω 28p
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4K 7 TO 2M LIN 38p
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Mini Horiz 15p
Standard Vert 18p
Standard Horiz 18p
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E12 MICRO MINI TYPICALLY + 5%
1pF to 10nF 7p
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8nF to 47nF 8p
56nF to 150nF 10p
100V
100nF to 150nF 11p
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330nF to 390nF 20p
470nF to 560nF 26p
680nF 30p
1μF (10mm) 35p
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10nF 15nF
22nF 33nF
47nF 68nF
100nF 7p
150nF 200nF 10p
330nF 470nF 13p
680nF 18p
1μF 22p
1 5uF 39p
2 2uF 39p
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1nF 500V 7p
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TANT BEADS
1 35V 14p
22 35V 14p
33 35V 14p
47 35V 14p
68 35V 14p
1 0 35V 14p
2 2 35V 14p
3 3 35V 18p
4 7 16V 18p
4 7 35V 20p
6 8 25V 20p
6 8 35V 21p
10 16V 18p
10 35V 27p
15 10V 22p
15 16V 30p
15 25V 32p
22/6 3V 26p
22 16V 29p
33 10V 30p
47 35V 14p
47 6 3V 34p
47 16V 39p
100 3V 32p
100 3V 55p

ELECTROLYTICS Mainly Matsushita (Panasonic) &

Siemens AXIALS (Wires each end)

uFd	V	
.47	63	8p
.47	100	9p
.47	350	30p
1	63	8p
1	100	9p
1	500	40p
2 2	25	8p
2 2	63	9p
2 2	100	11p
2 2	350	30p
3 3	25	10p
3 3	40	11p
3 3	63	12p
4 7	16	8p
4 7	25	9p
4 7	40	11p
4 7	63	12p
4 7	100	14p
10	25	8p
10	40	12p
10	63	14p
10	100	16p
10	350	55p
22	25	11p
22	40	14p
22	63	16p
22	100	21p
47	25	14p
47	40	17p
47	63	26p
47	100	28p
100	16	14p
100	25	16p
100	40	22p
100	63	25p
100	100	30p
220	10	16p
220	16	17p
220	25	22p
220	40	25p
220	63	30p
220	100	40p
470	16	22p
470	25	28p
470	40	33p
470	63	43p
470	100	60p
1000	16	30p
1000	25	38p
1000	40	46p
1000	63	65p
2200	16	40p
2200	25	63p
2200	40	70p
2200	63	1 34p
4700	16	75p
4700	25	89p

RADIALS (PCB wires one end)
Matsushita only

uFd	V	
10	16	6p
22	10	6p
22	16	7p
47	10	7p
47	16	8p
100	10	9p
220	10	11p
220	16	12p
470	10	17p
470	16	18p
1000	10	20p
1000	16	24p
2200	10	34p
2200	16	44p
3300	10	50p
3300	16	65p
4700	10	65p
4700	16	95p

74TTL

7400, 7401, 7402, 7403, 7404, 7405, 7408, 7409, 7410, 7411, 7412, 7413, 7414, 7416, 7417, 7420, 7421, 7422, 7423, 7425, 7426, 7427, 7428, 7430, 7432, 7433, 7437, 7440, 7441, 7442, 7443, 7444, 7445, 7446, 7447, 7448, 7450, 7451, 7453, 7454, 7460, 7470, 7472, 7473, 7474, 7475, 7476, 7480, 7481, 7482, 7483, 7484, 7485, 7486, 7489, 7490, 7491, 7492, 7493, 7494, 7495, 7496, 7497, 74100, 74104, 74105, 74107, 74109, 74110, 74116, 74118, 74119, 74120, 74121, 74122, 74123, 74125, 74126, 74128, 74132, 74136, 74141, 74142, 74143, 74144, 74145, 74147, 74148, 74150, 74151, 74153, 74154, 74155, 74156, 74157, 74159, 74160, 74161, 74162, 74163, 74164, 74165, 74166, 74170, 74172, 74173, 74174, 74175, 74176, 74177, 74178, 74180, 74181, 74183, 74184, 74185, 74186, 74188, 74190, 74191, 74192, 74193, 74194, 74195, 74196, 74197, 74198, 74199, 74221

74LS TTL

74LS00, 74LS01, 74LS02, 74LS03, 74LS04, 74LS05, 74LS08, 74LS10, 74LS11, 74LS12, 74LS13, 74LS14, 74LS15, 74LS20, 74LS21, 74LS22, 74LS27, 74LS28, 74LS30, 74LS32, 74LS33, 74LS37, 74LS38, 74LS40, 74LS42, 74LS47, 74LS51, 74LS54, 74LS55, 74LS73, 74LS74, 74LS75, 74LS76, 74LS78, 74LS83, 74LS85, 74LS86, 74LS90, 74LS92, 74LS93, 74LS95, 74LS96, 74LS107, 74LS109, 74LS112, 74LS113, 74LS114, 74LS122, 74LS123, 74LS124, 74LS125, 74LS126, 74LS132, 74LS133, 74LS136, 74LS138, 74LS139, 74LS145, 74LS147, 74LS148, 74LS151, 74LS153, 74LS154, 74LS155, 74LS156, 74LS157, 74LS158, 74LS160, 74LS161, 74LS162, 74LS163, 74LS164, 74LS165, 74LS168, 74LS169, 74LS170, 74LS173, 74LS174, 74LS175, 74LS181, 74LS183, 74LS190, 74LS191, 74LS192, 74LS193, 74LS194, 74LS195, 74LS196, 74LS197, 74LS221, 74LS240, 74LS241, 74LS242, 74LS243, 74LS244, 74LS245, 74LS247, 74LS248, 74LS249, 74LS251, 74LS253, 74LS257, 74LS258, 74LS259, 74LS261, 74LS266, 74LS273, 74LS275, 74LS279, 74LS280, 74LS283, 74LS289, 74LS290, 74LS293, 74LS295, 74LS298, 74LS299, 74LS323, 74LS324, 74LS325, 74LS326, 74LS327, 74LS347, 74LS348, 74LS352, 74LS353, 74LS362, 74LS365, 74LS366, 74LS367, 74LS368, 74LS373, 74LS378, 74LS386, 74LS390, 74LS393, 74LS395, 74LS396, 74LS398, 74LS399, 74LS445, 74LS490, 74LS540, 74LS541, 74LS640, 74LS641

CMOS

4000	16p
4001	16p
4002	16p
4006	49p
4007	19p
4008	32p
4009	24p
4010	24p
4011	16p
4012	19p
4013	19p
4014	46p
4015	39p
4016	19p
4017	32p
4018	45p
4019	24p
4020	42p
4021	39p
4022	39p
4023	19p
4024	32p
4025	19p
4026	79p
4027	28p
4028	39p
4029	43p
4030	19p
4031	1 19
4032	79p
4033	1 19
4034	1 29
4035	44
4036	2 49
4037	1 13
4038	99p
4039	2 45
4040	39p
4041	39p
4042	39p
4043	39p
4044	39p
4045	99p
4046	44p
4047	69p
4048	39p
4049	22p
4050	23p
4051	44p
4052	58p
4053	49p
4054	79p
4055	83p
4056	83p
4059	4 35
4060	42p
4063	79p
4066	22p
4067	2 39
4068	19p
4069	19p
4070	19p
4071	19p
4072	19p
4073	19p
4075	19p
4076	45p
4077	19p
4078	19p
4081	19p
4082	19p
4085	49p
4086	60p
4089	1 23
4093	19p
4094	69p
4095	71p
4096	69p
4097	2 88
4098	74p
4099	89p
4502	55p
4503	39p
4507	33p
4508	1 26
4510	44p
4511	44p
4512	48p
4514	1 13
4515	1 13
4516	55p
4518	39p
4519	29p
4520	48p
4521	88p
4526	68p
4527	62p
4528	74p
4532	69p
4534	3 96
4536	2 59
4538	78p
4539	89p
4543	68p
4553	2 25
4555	35p
4556	35p
4560	1 49
4566	1 49
4569	1 65
4584	39p
4585	59p

LOGIC CPUs

1802	6 50
2550A	11 99
6502	3 24
6800	2 10
6802	2 40
6809	6 20
8035	3 49
8080A	2 50
8085A	3 49
Z80A	2 98
Z80B	8 60

MEMORIES

2114(200ns)	99p
2532	3 25
2564	6 25
2708	3 50
2716 (5v)	2 65
2764	4 25
4116(200ns)	99p
4118-3	3 25
5204	7 50
6116P3	3 85
6514	3 30
6810	1 45
7489	1 65
74189	4 00
74LS188	2 25
74LS287	3 05
74LS288	2 25
74LS289	3 25

MISC LOGIC IC s

ADC0804	4 40
ADC0816	14 95
ADC0817	10 39
INS1671	20 00
INS1771	14 50
RO2513LC	7 50
RO2513UC	7 50
SAA5000	3 00
SAA5010	7 10
SAA5012	7 10
SAA5020	5 50
SAA5030	9 00
SAA5040	15 00
SAA5041	15 00
SAA5050	8 50
SAA5052	8 50
SAA5070	16 95
8T26	95p
8T28	1 20
8T95	85p
8T97	85p
81LS95	80p
81LS96	85p
81LS97	80p
81LS98	85p
6522	3 19
6532	5 70
8154	9 00
8155	3 50
8212	1 70
8216	99p
8224	1 95
8226	2 50
Z80ACTC	2 60
Z80ADART	5 50
Z80ADMA	6 70
Z80APIO	2 70
ZN426E8	3 39
ZN426E8	2 97
ZN427E8	5 99

V.REGS

Positive 100mA

78L05A	29p
78L12A	29p
78L15A	29p
78L24A	29p

1 Amp TO202

7805T	45p
7812T	45p
7815T	45p
7824T	45p

Negative 100 mA TO92

79L05	49p
79L12	49p
79L15	49p

1 Amp TO220

7905T	57p
7912T	57p
7915T	57p
7924T	57p

TRANSISTORS

2N2219	27p
2N2219A	28p
2N2220	22p
2N2221	22p
2N2221A	23p
2N2222	24p
2N2222A	25p
2N2223	2 60
2N2223A	4 15
2N2368	25p
2N2369	19p
2N2369A	20p
2N2904A	27p
2N2905	29p
2N2905A	29p
2N2906	25p
2N2906A	30p
2N2907	25p
2N2907A	26p
2N2920	9 25
2N2926	10p
2N3053	27p
2N3054	56p
2N3055	60p
2N3055H	1 20
2N3439	98p
2N3440	80p
2N3441	1 25
2N3442	3 96
2N3553	2 65
2N3638	55p
2N3702	10p
2N3703	10p
2N3704	10p
2N3705	10p
2N3706	10p
2N3707	10p
2N3708	10p
2N3709	10p
2N3710	10p
2N3711	10p
2N3712	2 00
2N3713	1 38
2N3714	2 98
2N3715	3 31
2N3716	3 60
2N3773	1 99
2N3819	35p
2N3820	68p
2N3866	90p
2N3903	13p
2N3904	13p
2N3905	13p
2N3906	13p
2N4030	75p
2N4031	65p
2N4032	69p
2N4036	63p
2N4037	90p
2N4240	3 00
2N4400	15p
2N4401	27p
2N4402	30p
2N4902	1 85
2N4903	1 98
2N4904	2 15
2N4905	2 75
2N4906	2 99
2N4907	3 20
2N4908	3 15
2N4909	2 90
2N5089	37p
2N5190	68p
2N5191	70p
2N5194	79p
2N5245	37p
2N5246	40p
2N5247	45p
2N5248	46p
2N5249	48p
2N5266	2 88
2N5293	98p
2N5294	1 28
2N5295	1 37
2N5401	35p
2N5415	1 10
2N5416	1 54
2N5447	16p
2N5448	19p
2N5449	21p
2N5450	23p
2N5451	25p
2N5457	29p
2N5458	29p
2N5459	29p
2N5460	72p
2N5551	37p
2N5884	5 95
2N5886	5 95
2N6122	59p
2N6123	65p
2N6124	59p
2N6125	65p
2N6126	75p
2N6129	79p
2N6100	93p
2N6131	98p
2N6132	83p
2N6133	1 14
2N6134	1 36
2N6253	1 45
2N6254	1 55
2SC1306	95p
2SC2078	1 70
2SJ49	3 95
2SJ50	4 50
2SJ82	4 75
2SK134	3 95
3SK135	4 50
2SK226	4 75
3N128	1 12
3N140	1 07
3N200	6 93
3N201	2 98
40360	60p
40361	67p
40362	67p
40363	2 95
40406	1 39
40407	75p
40408	1 59
40410	1 80
40411	3 95
40412	90p
40673	70p
40822	1 80
40871	1 00
40872	1 00
AC125	49p
AC126	32p
AC127	32p
AC128	35p
AC132	68p
AC141K	28p
AC142K	28p
AC151	51p
AC152	45p
AC153	55p
AC153K	64p
AC176	27p
AC176K	37p
AC187	25p
AC187K	28p
AC188	25p
AC188K	40p
AF239	55p
AF240	1 00
BC107	10p
BC107A	12p
BC107B	12p
BC108	10p
BC108A	12p
BC108B	12p
BC108C	12p
BC109	10p
BC109B	12p
BC109C	12p
BC140	29p
BC141	37p
BC142	29p
BC143	30p
BC147	10p
BC147A	10p
BC147B	10p
BC147C	10p
BC148	10p
BC148A	10p
BC148B	13p
BC148C	13p
BC149	10p
BC149B	12p
BC149C	13p
BC152	35p
BC153	23p
BC154	27p
BC157	11p
BC157A	12p
BC157B	13p
BC158	10p
BC158A	12p
BC158B	13p
BC159	11p
BC159A	12p
BC159B	13p
BC159C	18p
BC160	42p
BC161	48p
BC167	10p
BC167A	10p
BC167B	13p
BC168	10p
BC168B	10p
BC168C	10p
BC169	10p
BC169B	10p
BC169C	10p
BC177	16p
BC177A	25p
BC177B	26p
BC178	16p
BC178A	24p
BC178B	25p
BC179	20p
BC179A	25p
BC179B	25p
BC179C	27p
BC182	10p
BC182A	12p
BC182B	13p
BC182L	10p
BC182LA	13p
BC182LB	14p
BC183	10p
BC183A	11p
BC183B	12p
BC183C	13p
BC183L	10p
BC183LA	13p
BC183LB	13p
BC183LC	14p
BC184	10p
BC184B	12p
BC184C	13p
BC184L	10p
BC184LB	13p
BC184LC	14p
BC186	24p
BC187	24p
BC212	12p
BC212A	12p
BC212B	13p
BC212L	10p
BC212LA	13p
BC212LB	14p
BC213	10p
BC213A	11p
BC213B	12p
BC213C	13p
BC213L	10p
BC213LA	13p
BC213LB	13p
BC213LC	14p
BC214	10p
BC214B	12p
BC214C	13p
BC214L	10p
BC214LB	13p
BC214LC	14p
BC237	14p
BC237A	16p
BC237B	17p
BC237C	18p
BC238	14p
BC238A	15p
BC238B	16p
BC238C	17p
BC239	15p
BC239A	16p
BC239B	17p
BC239C	18p
BC300	45p
BC301	44p
BC302	43p
BC303	47p
BC327	14p
BC328	14p
BC337	15p
BC338	15p
BC440	32p
BC441	33p
BC460	32p
BC461	33p
BC516	40p
BC517	40p
BC546B	15p
BC547	13p
BC556B	15p
BC547A	14p
BC547B	14p
BC548	12p
BC548A	14p
BC548B	14p
BC548C	15p
BC549	13p
BC549B	14p
BC549C	15p
BC550	15p
BC550C	25p
BC557	15p
BC557A	16p
BC557B	16p
BC558	14p
BC558A	15p
BC558B	16p
BC558C	17p
BC559	15p
BC559B	16p
BC559C	17p
BC560	25p
BC560C	25p
BC650	45p
BC651	46p
BC700	16p
BC701	16p
BC702	19p
BD131	44p
BD132	44p
BD135	35p
BD136	35p
BD137	37p
BD138	37p
BD139	38p
BD140	38p
BD237	98p
BD238	98p
BD239A	57p
BD239C	64p
BD240A	53p
BD240C	73p
BD241A	61p
BD241C	67p
BD242A	65p
BD242C	70p
BD243A	72p
BD243C	85p
BD244A	82p
BC244C	1 00
BD245A	1 14
BD245C	1 30
BD246A	1 20
BD246C	1 50
BC249A	2 00
BC249C	2 31
BD250A	2 11
BD250C	2 46
BD419	1 29
BD420	1 37
BD437	88p
BD438	88p
BD439	90p
BD440	91p
BD441	91p
BD442	93p
BD529	1 20
BD530	1 30
BD535	75p
BD536	75p
BD537	80p
BD539	80p
BD539	80p
BD539C	1 10
BD540	85p
BD540C	1 20
BD675	72p
BD676	77p
BD677	78p
BD678	83p
BD711	1 32
BD712	1 32
BDX32	3 47
BDX66B	5 95
BDX67B	5 95
BDY54	1 70
BDY55	1 75
BDY56	1 80
BDY57	5 25
BDY58	6 15
BF194	12p
BF195	12p
BF196	12p
BF197	12p
BF198	15p
BF199	15p
BF200	75p
BF224J	32p
BF225J	35p
BF244A	55p
BF244B	55p
BF245A	55p
BF245B	65p
BF246	70p
BF246A	70p
BF246B	70p
BF247A	75p
BF247B	75p
BF254	39p
BF255	42p
BF256A	58p
BF256B	58p
BF256C	65p
BF257	30p
BF258	32p
BF259	35p
BF457	46p
BF458	56p
BF459	62p
BF469	86p
BF470	86p
BF839	25p
BFR40	25p
BFR41	25p
BFR79	25p
BFR80	25p
BFR81	25p
BFR90	2 11
BFS28	2 95
BFS61	1 00
BFS98	1 10
BFX29	26p
BFX30	27p
BFY50	23p
BFY51	23p
BFY52	23p
BFY53	31p
BSX19	24p
BSX20	24p
BSX21	40p
BU104	2 22
BU105	1 70
BU108	3 95
BU109	3 29
BU126	1 47
BU204	2 25
BU205	1 75
BU206	1 89
BU208	1 98
BU226	3 95
BU326S	2 35
BU406	1 45
BU407	1 45
BU408	1 55
BU500	2 95
BUY18S	3 95
F430	5 95
J300	70p
J310	70p
MJ802	3 99
MJ900	2 90
MJ901	3 10
MJ1000	2 50
MJ1001	3 00
MJ1800	3 60
MJ2500	2 19
MJ2501	2 25
MJ2955	1 00
MJ3000	2 19
MJ3001	2 25
MJ4502	3 99
MJ15003	4 85
MJ14004	5 55
MJ15015	2 45
MJ15016	3 34
MJE340	53p
MJE350	58p
MJE2955	1 95
MJE3055	1 95
MJE2955T	99p
MJE3055T	69p
MPSA05	23p
MPSA06	25p
MPSA10	28p
MPSA12	29p
MPSA13	48p
MPSA14	46p
MPSA16	30p
MPSA18	65p
MPSA20	48p
MPSA42	49p
MPSA43	49p
MPSA55	28p
MPSA56	30p
MPSA65	40p
MPSA66	47p
MPSA70	45p
MPSA92	39p
MPSA93	39p
MPSL01	84p
MPSL51	49p
MPSU01	84p
MPSU04	1 32
MPSU05	55p
MPSU06	56p
MPSU07	75p
MPSU51	88p
MPSU55	58p
MPSU56	59p
MPSU57	1 20
NE5532	1 65
TIP29A	29p
TIP29C	38p
TIP30A	35p
TIP30C	36p
TIP31A	33p
TIP31C	34p
TIP32A	38p
TIP32C	42p
TIP33A	65p
TIP33C	78p
TIP34A	74p
TIP34C	88p
TIP35A	1 09
TIP35C	1 28
TIP36A	1 29
TIP36C	1 39
TIP41A	49p
TIP41C	55p
TIP42A	55p
TIP42C	59p
TIP49	1 20
TIP50	1 40
TIP53	1 59
TIP54	1 59
TIP110	74p
TIP112	90p
TIP115	81p
TIP117	96p
TIP120	69p
TIP122	73p
TIP125	84p
TIP127	84p
TIP13D	93p
TIP132	93p
TIP135	99p
TIP137	99p
TIP140	1 04
TIP142	1 04
TIP145	1 15
TIP147	1 15
TIP162	4 95
TIP2955	77p
TIP3055	70p
TIS311	52p
TIS88A	80p
VN10KM	60p
VN46AF	95p
VN66AF	99p
ZTX107	10p
ZTX108	10p
ZTX109	12p
ZTX300	13p
ZTX301	15p
ZTX302	15p
ZTX303	23p
ZTX304	15p
ZTX310	35p
ZTX311	32p
ZTX312	35p
ZTX313	36p
ZTX314	24p
ZTX320	35p
ZTX330	35p
ZTX341	28p
ZTX450	39p
ZTX500	14p
ZTX501	14p
ZTX502	14p
ZTX503	17p
ZTX504	24p
ZTX510	24p
ZTX530	24p
ZTX531	25p
ZTX650	45p

DIODES

1N34A	30p
1N821	70p
1N823	92p
1N914	4p
1N916	6p
1N4001	4p
1N4002	4½p
1N4003	5p
1N4004	5½p
1N4005	6p
1N4006	6½p
1N4007	7p
1N4009	20p
1N4148	3p
1N4150	18p
1N4448	22p
1N5400	12p
1N5401	13p
1N5402	14p
1N5404	16p
1N5406	18p
1N5407	19p
1N5408	20p
1N5024	52p
1S44	10p
BA102	25p
BA115	25p
BA133	40p
BA138	30p
BA142	20p
BA155	15p
BA156	38p
BA157	25p
BA158	30p
BA159	32p
BA182	40p
BA201	18p
BA202	25p
BA316	25p
BA317	25p
BA318	30p
BAV10	16p
BAV19	15p
BAV20	15p
BAX13	10p
BB109G	65p
BY126	11p
BY127	12p

SCR's, TRIACS DIACS

THYRISTORS
4 8 & 12 Amps Texas TO220
Suffix A 100V
B 200V
C 300V
D 400V
M 600V

TIC106A	46p
TIC106B	47p
TIC106C	48p

4A

TIC106D	49p
TIC106M	68p
TIC116A	66p
TIC116B	68p

8A

TIC116C	71p
TIC116D	73p
TIC116M	80p
TIC126A	72p
TIC126B	72p

12A

TIC126C	73p
TIC126D	74p
TIC126M	96p

TRIACS
Texas 400V
TO220 Case

TIC206D(4A)	66p
TIC225D(6A)	74p
TIC226D(8A)	88p
TIC236D(12A)	1 16
TIC246D(16A)	1 22
TIC253D(20A)	1 90
TIC263D(25A)	2 11

DIACS

BR100	29p
ST2	29p

ZENER'S
many inc specials see our CAT
400 500mW E24 Series
2 4 47V 7p
1 3 Watt E24 Series
3 3 82V 14p

BRIDGE
(PIV shown in brackets)
1½ amp type

W01 (100)	28p
W02 (200)	34p
W04 (200)	38p
W08 (800)	50p

2 amp type
Square with hole

S01 (100)	46p
S02 (200)	50p
S04 (400)	55p
S08 (800)	66p

6 amp type
Square with hole

PW01 (100)	95p
PW02 (200)	99p
PW04 (400)	1 30
PW06 (600)	1 39

25 amp type
Metal clad with hole

K01 (100)	2 62
K02 (200)	2 75
K04 (400)	3 25
K06 (600)	4 10
BYW64 35A 400V	4 50

OPTO

many inc specials see out CAT.

LED LAMPS
R Red
G Green
Y Yellow

Large Diffused

	1
R5D	9p
G5D	15p
Y5D	15p

Small diffused

R3D	8p
G3D	12p
Y3D	12p

Micro 0 1

R1M	25p
G1M	27p
Y1M	27p

Lage clear

R5C	12p
G5C	17p
Y5C	17p

Super bright high efficiency
Large (100 times brighter)

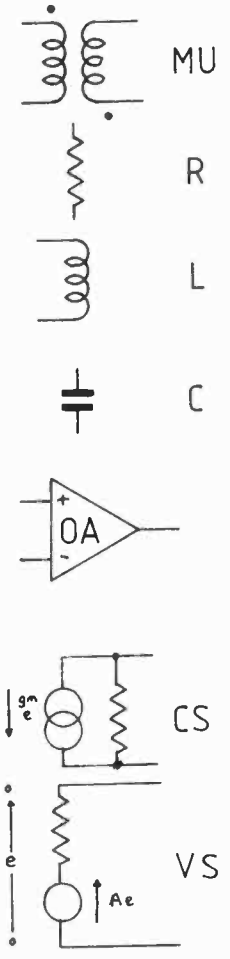
R5U	38p
G5U	42p
Y5U	42p

Rectangular
Stackable LEDs

R5R	17p
G5R	18p
Y5R	19p

LINICS

AY1 5050	95p
AY3 8910	3 99
AY3 8912	4 95
CA3048	2 15
CA3059	2 80
CA3090AQ	3 70
CA3130E	87p
CA3130T	2 35
CA3140E	39p
CA3140T	1 40
HA1366W	2 40
HA388	2 54
ICL7106	7 50
ICL7107	9 50
ICL7611	97p
ICL8038	2 99
ICM7555	80p
ICM7556	1 50
LC7120	3 20
LC7130	3 40
LC7137	3 95
LF347	1 50
LF351	47p
LF353	92p
LF355	83p
LF356	92p
LF357	1 30
LF398	4 62
LM3352	1 60
LM348N	62p
LM349N	1 09
LM350K	4 60
LM379S	5 50
LM380N14	75



CIRCUIT MODELLER for CP/M

by Harcourt Systems

An engineering package for CP/M and MS DOS* microcomputers to carry out accurate, fast designs of linear circuits.*

CIRCUIT MODELLER can find voltage gain, phase shift, Z_{in} and Z_{out} for most linear electrical and electronic circuits. The limits of capacity are set by the microcomputer RAM, which must be at least 60 KBytes. This gives a capacity of 32 nodes, 101 resistors, 101 capacitors, 101 inductors, 31 mutual inductors, 31 simple operational amplifiers and 31 controlled sources.

Features include:

ADD & EDIT	to construct and alter circuit
LOAD & SAVE	to save and recover circuit from disk
GAIN	to display gain and phase
ZIN	to display input and output impedances
BW	to find centre frequency and −3dB Av points of circuit
SEARCH	to find frequency corresponding to given gain
PRINT	to print synopsis of circuit diagram sufficient for its precise reproduction.

Operating Speed

CIRCUIT MODELLER is an all-compiled package with seven overlays in which the inner two loops of pivotal condensation are written in Z80 assembler. This means that whereas microcomputer CAD is usually slow, **CIRCUIT MODELLER** can solve a four hybrid-pi amplifier in a few seconds.

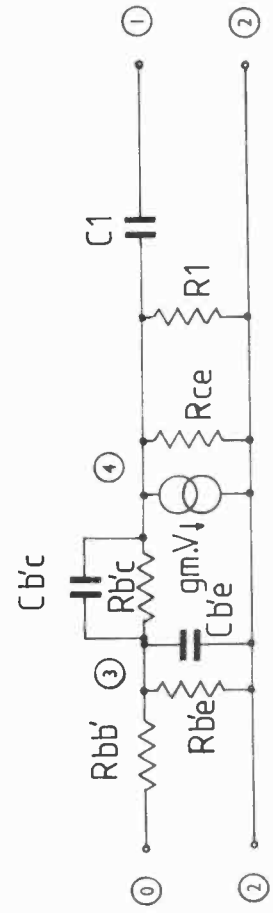
Graphics

PLOT is an extension to **CIRCUIT MODELLER** enabling an ordinary 132 column printer to plot both dB gain and phase angle against frequency for the circuit. A log/log plot is obtained with automatic axis scaling.

Themselves designers of high performance electronic equipment, Seasim Controls have recognised the importance of **CIRCUIT MODELLER** which they are making available in association with Harcourt Systems. **CIRCUIT MODELLER** is priced at £160+VAT. Prices for MS DOS on application. Order, or send for more details from

SEASIM CONTROLS LIMITED
The Paddocks, Frith Lane, Mill Hill, London NW7 1PS
Telephone: (01) 346 9271 – Telex: 21189

*CP/M is a trademark of Digital Research
*MS DOS is a trade mark of Microsoft



WW – 075 FOR FURTHER DETAILS

BULK PURCHASE BARGAINS

CAPACITORS

AXIAL

Value/Volts	Qty.	Price each per 100	Price each per 1K	Price each per 10K
100/10	89000	0.07	0.04	.025
220/10	5000	0.08	0.05	
2200/10	10000	0.19	0.10	0.07
4700/10	4000	0.32	0.20	
100/16	4000	0.07	0.04	
470/16	400	0.11		
47/40	9000	0.09	0.05	
100/40	2500	0.11	0.07	
150/40	7000	0.11	0.07	
4700/40	400	0.55		
4.7/50	2800	0.05	0.03	
3.3/63	1400	0.06	0.04	
4.7/63	300	0.06	0.04	
.47/63	6000	0.04	0.025	
1000/63	450	0.32		
100/100	450	0.15		
1/160	2000	0.05	0.025	
10/160	18000	0.08	0.05	0.04
4.7/450	4000	0.07	0.045	
22/500	1500	0.05	0.04	
4.7/500	350	0.06		
470/6.3	900	0.11		
1/250	1000	0.07		
CERAMIC FILTERS				
10.7 Mhz	15000	0.15	0.10	0.05
INDUCTORS				
82μH	35000	0.15	0.10	0.05
33μH	16000	0.15	0.10	0.05

RADIAL

Value/Volts	Qty.	Price each per 100	Price each per 1K	Price each per 10K
47/10	3600	0.04	0.03	
330/10	69500	0.05	0.03	0.02
1000/10	7400	0.08	0.05	
33/16	47000	0.04	0.03	0.02
33/25	19600	0.04	0.025	0.02
330/25	3000	0.07	0.05	
100/40	9200	0.06	0.04	
47/40	3000	0.05	0.03	
100/63	23400	0.11	0.07	0.05
2.2/100	2800	0.03	0.02	
330/40	850	0.09	0.05	
22/100	1900	0.05	0.03	
220/100	8400	0.18	0.11	
47/160	1000	0.12	0.07	
10/200	1000	0.04	0.025	
47/250	1500	0.05	0.03	
4.7/450	550	0.03		
CERAMICS				
10pf	24000	All one price		
39pf	56000			
47pf	118000	£10 per 100		
20pf	16000	£25 per 10K		
51pf	100000	£125 per 100K		
33pf	48000			
120pf	16000	Any mix		
12pf	16000			
6800pf	36500			
4700pf	6000			
120pf	1800			
150pf	75000			
15pf	40000			
12pf	16000			
68pf	20000			
22pf	2000			
39pf	5000			
47pf	14000			

All components are new and boxed. Carriage additional. All prices exc. V.A.T.

TIMEBASE

94 ALFRISTON GARDENS, SHOLING, SOUTHAMPTON SO2 8FU

TEL. 431323 (0703)

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P. F. RALFE ELECTRONICS

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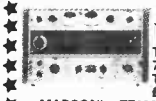
★ MARCONI SIGNAL GENERATORS ★



TF2002A/S (illustrated) 10kHz-72MHz. AM/FM. **£750**
TF2002. As above but AM only. **£450**
MARCONI TF1066B. AM/FM Generator. 10-470MHz. 0.2uV-200mV output. FM Deviation up to ±100kHz.
MARCONI TF995A/5. AM/FM Generator. Narrow deviation model 995 covering 1.5-220MHz. **£450**. TF2015. 10-520MHz. AM/FM. TF144H. AM 10kHz-72MHz **£295**.
MARCONI TF1064B/5. AM/FM Signal generator covering in three ranges 68-108, 118-185 and 450-470MHz. FM fixed deviations of 3.5 & 10kHz. AM fixed 30%. **£225**

★ 'DOLBY' NOISE WEIGHTING FILTERS ★

Cat. No. 98A. Noise weighting filters for CCIR/ARM signal-to-noise ratio measurements. As new units. **£40** each (+£1 p&p).

BECKMAN TURNS COUNTER DIALS

Miniature type (22mm diam.). Counting up to 15 turn "Helipots". Brand new with mounting instructions. Only **£2.50** each.

RFI RECEIVER

Stoddart Model NM52A. RF Noise & Field intensity measuring receiver. 375MHz-1GHz c/w power supply unit.

KAY SOUND SPECTROGRAPH

Model 6061B with Amplitude Display, scale magnifier. 85Hz-16kHz. Complete sound spectrograph in excellent condition.

★★ STEPPER MOTORS ★★

Brand new stock of 'ASTROSYN' Type 20PM-A055 stepper motors. 28V DC. 24 steps per rev. 15 oz-in torque @ 100PPS. Body length 2½", diameter 2", shaft ¼" diam × 4¼" spirally threaded. Weight 16oz. Price each **£15** (p&p 50p). Connections supplied.

★ MILLI-VOLT MEASUREMENT, ANALOGUE ★

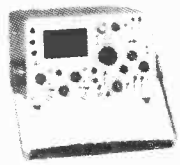
MARCONI TF2600. Twelve ranges 1mV-300V FSD. Wide-band to 10MHz.
MARCONI TF2603. Frequency range 50kHz-1.5GHz. High Sensitivity from 300uV.
MARCONI TF2604. Electronic Multi-meter. AC/DC 300mV Full scale to 300V (1kV DC). Resistance ranged. AC Frequency range 20Hz-1500MHz.

★★ CONSTANT VOLTAGE TRANSFORMERS ★★

'ADVANCE VOLSTAT; Type. Model MT140A. Mains input 190-260V AC. Output 230V AC @ 150W. Price each **£20** + VAT + £2 carriage.

'OSCILLOSCOPES' PLEASE PHONE FOR CURRENT STOCK

TEKTRONIX 453. Dual-trace 50MHz.
TEKTRONIX 565. Dual time-base. Differential plug-ins.
SOLARTRON CD1740. 50MHz sweep-delay **£350**.
MARCONI TF2210 Dual-trace, 100MHz, sweep-delay **£350**.
MARCONI TF2604 Electronic Multi-Meter
MARCONI TF893A Audio Power Meters **£85**.
MARCONI TF2502 RF Power Meters. DC-1GHz. 10w fsd **£350**.
MARCONI TF2701 In-Situ Universal Component Bridge **£250**.
MEGGER-5KV Insulation Tester. Hand-crank.
MARCONI TF2343A Quantization Distortion Meter **£150**.
HEWLETT-PACKARD 3450A Multi-Function Digital Multi-Meter.
ROHDE & SCHWARZ 'SDR' AM Signal Generator 0.3-1GHz.
TEKTRONIX 2901 Time-mark Generator.
GOULD J3B Signal Generator **£150**.
ROHDE & SCHWARZ Resonance Frequency Meter 470MHz-2.5GHz.
HEATHKIT AW1U Audio Power Meters 5mW-50W **£25** pp £1.
METROHM 500V Insulation Testers Transistorised **£40** pp £1.50.
BRUEL & KJAER Heterodyne Voltmeter 0.5-240MHz.
AIRMEC Display Oscilloscope 279, 4-trace, 14x10" CRT **£195**.
RIKADENKI 3-channel Chart Recorder, Model B-341.



★ AVO SIGNAL GENERATORS AFM2 ★

We have in stock a quantity of AVO type AFM2 signal generators supplied in fully tested working condition complete with accessories. Spec as follows: 0.45MHz-225MHz in 8 bands, AM all bands plus FM on two bands covering 20-100MHz. Output 1uV-50mV and 200mV High O/P setting, m/c set level meter, scale shift for accurate frequency calibration, variable mod etc. PRICE EACH JUST **£55** + VAT. Carriage each + £4.

★ SWEEPERS ★

TELONIC Sweep generator system type 2003. Fitted with Marker, attenuator, Detector plug-in units and Generator covering 800-1500MHz. **£325**

MUIRHEAD ★ FACSIMILE UNITS ★

MUFAX 'COURIER' facsimile receiver type K441-CH and transmitters K400 AMCH in stock in excellent condition **£250** per pair.

PLEASE NOTE. All the pre-owned equipment shown has been carefully tested in our workshop and reconditioned where necessary. It is sold in first-class operational condition and most items carry a three months' guarantee. For our mail order customers we have a money-back scheme. Repairs and servicing to all equipment at very reasonable rates. PLEASE ADD 15% VAT TO ALL PRICES.

★ COMPUTER PERIPHERALS ★

8" FLOPPY DISK DRIVES

DRE (Data Recording Equipment) Model 7100 Single-sided floppy disk drives in stock now at vastly reduced prices. Supplied BRAND NEW in manufacturers sealed cartons. CAPACITY 0.8MBytes. Hard/Soft sectoring ANSI/ECMA Standards compatible. Measures 4½×8½×14". Weight 13lbs. PRICE £150 + VAT. Securicor despatch if required + £10 + VAT. 7200 (Double-sided) **£250**

8" WINCHESTER DRIVES

United Peripherals type 3100 Minidisc Drives CAPACITY over 19MBytes. Power supply requirements 5V.DC at 4A. +24V. DC at 3A. Measures 17×8×7". Limited quantity only available in BRAND NEW condition. **£250** each + VAT. Carriage details as above.

4000-SERIES HARD DISK DRIVES

Data Recording Equipment 4000-Series exchangeable IBM-type 5440 Disks. Units available ex-stock and BRAND NEW. Please call us for our lowest ever quotation.

★ DISK CARTRIDGES ★

Surplus BASF 12-Sector RK05 cartridges available ... small quantity only remaining at **£15** each. Carriage each £1.50.

★ SWITCHING POWER SUPPLIES ★

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3.5V @ 10 Amps	**£15**	5V @ 10 Amps	**£15**
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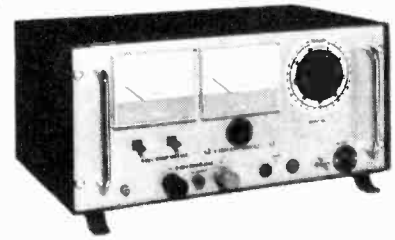

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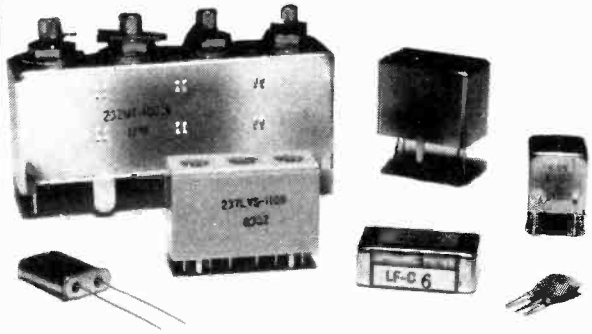

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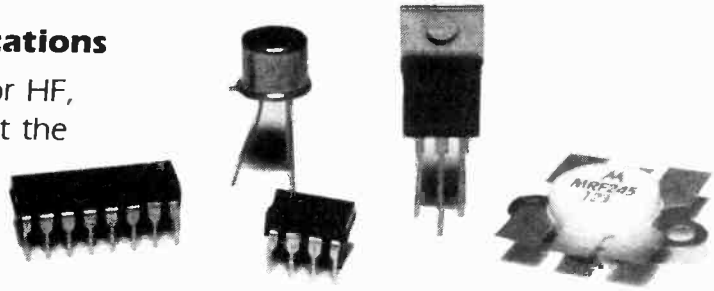

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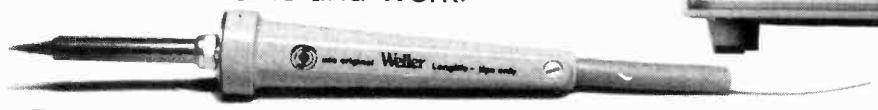

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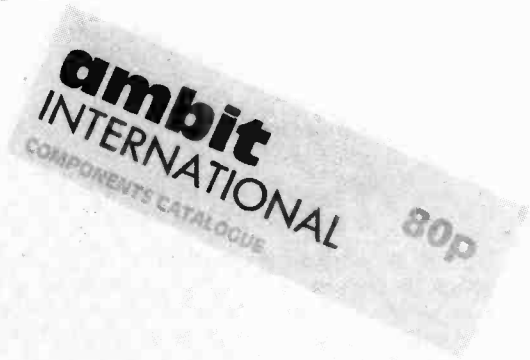

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(2488)

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(2482)

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Further details and application form from EO/Estab 1b, Inner London Education Authority, Room 365, The County Hall, London SE1 7PB.

The closing date for receipt of completed application forms is **29th February, 1984.**

This vacancy is suitable for job sharing.

All applicants will be given equal consideration irrespective of sex, age, disabilities, race, colour, ethnic or national origins, marital status, sexual orientation, family responsibility, trade union activity or political belief.

(2456)

British Antarctic Survey

Radio Officers (Marine)

Vacancies exist for Radio Officers (Marine) to serve on the Survey's research vessels. Successful applicants would be required to commence duties on August 1, 1984. Voyages are normally seven months long and vessels sail from the United Kingdom in the autumn.

The Survey's vessels re-supply Antarctic land stations, support scientific parties in the field and in addition undertake shipborne research.

Candidates should possess valid certificates of proficiency recognised by the Department of Trade and have served the necessary sea time to work a single-handed station.

Starting salary in a scale up to £8,640, rising to £10,917 per annum. In addition an allowance of £1,200 per annum is payable for periods of service spent south of Montevideo.

For further details and an application form, please write, stating full qualifications and experience, to: The Establishment Officer, British Antarctic Survey, High Cross, Madingley Road, Cambridge CB3 0ET. Please quote ref: BAS 5. Closing date: March 14, 1984.

NATURAL ENVIRONMENT RESEARCH COUNCIL

(2492)

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(Ref: RE3)

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(2460)

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If you are able to conceive, design and implement production test equipment with minimal supervision, we'd like to hear from you.

These positions are based in our Chessington Engineering Centre but some visits to our factories in the North East and Lancashire will be required at infrequent intervals. Salaries are obviously dependent on qualifications and experience, but will reflect the importance of future test gear projects to the Company's long term development.

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REDIFFUSION

(2408)

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(2453)

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(2467)

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(2486)

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SONY Broadcast

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(2469)

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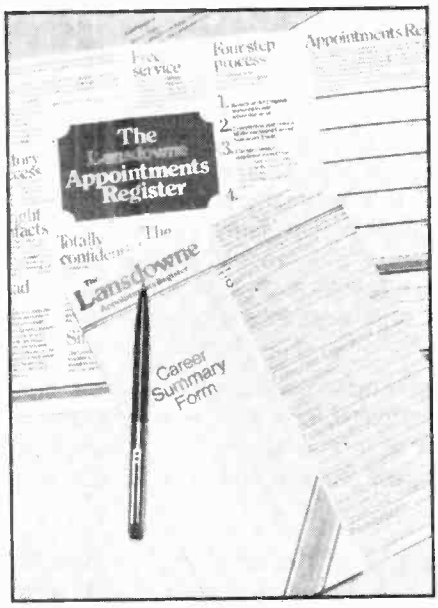

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(2464)

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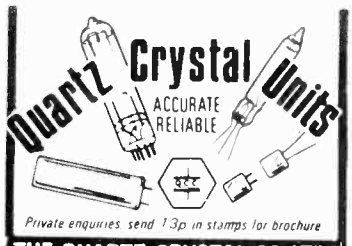

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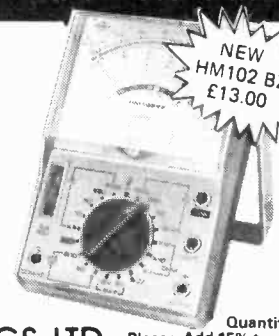

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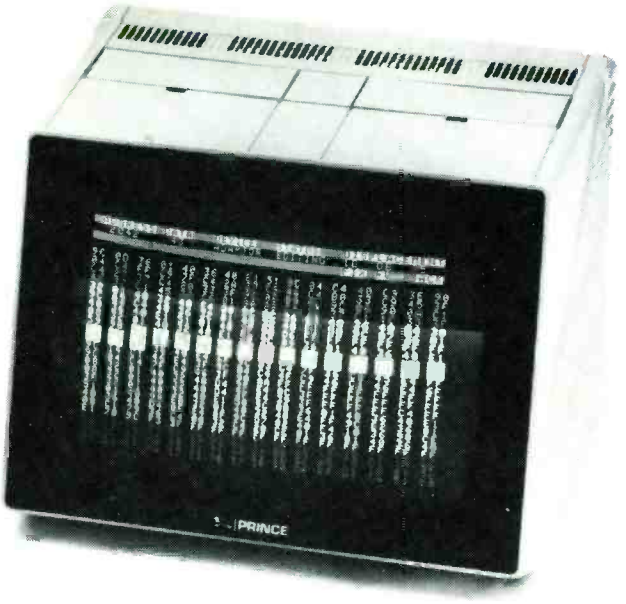
EP8000 EPROM EMULATOR PROGRAMMER

NEW PRODUCT



The new microprocessor controlled EP8000 Emulator Programmer will program and emulate all EPROMs up to 8k x 8 sizes, and can be extended to program other devices such as 16k x 8 EPROMs, Bipolar PROMs, single chip microprocessors with external modules.

Personality cards and hardware changes are not required as the machine configures itself for the different devices.

The EP4000 with 4k x 8 static RAM is still available with EPROM programming and emulation capacity up to 4k x 8 sizes.

FEATURES

- Software personality programming/emulation of all EPROMs up to 8k x 8 bytes including 2704, 2708, 2716(3), 2508, 2758A, 2758B, 2516, 2716, 2532, 2732, 2732A, 68732-0, 68732-1, 68766, 68764, 2564, 2764. Programs 25128, 27128 with adaptors.
- No personality cards/characterisers required.
- Use as stand alone programmer, slave programmer, or EPROM development system.
- Checks for misplaced and reversed insertion, and shorts on data lines.
- Memory mapped video output allows full use of powerful editing facilities.
- Built-in LED display for field use.
- Powerful editing facilities include: Block/Byte move, insert, delete, match, highlight, etc.
- Comprehensive input/output – RS232C serial port, parallel port, cassette, printer O/P, DMA.
- Extra 1k x 8 scratchpad RAM for block moving.

● EP8000 8k x 8 Emulator Programmer – £695 + £12 delivery ● BSC8 Buffered emulation cable – £49 ● SA27128 Programming adaptor – £69 ● SA25128 Programming adaptor – £69 ● EP4000 4k x 8 Emulator Programmer – £545 + £12 delivery ● BSC4 Buffered emulation cable – £39 ● BP4 (TEXAS) Bipolar PROM Module – £190 ● Prinz video monitor – £99 ● UV141 EPROM Eraser with timer – £78 ● GP100A 80 column printer – £225 ● GR1 Centronics interface – £65

VAT should be added to all prices

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P8000 – THE PRODUCTION PROGRAMMER THAT HANDLES ALL NMOS EPROMS

NEW PRODUCT

- Checks, Programs, Compares up to 8 devices simultaneously
- Handles all NMOS EPROMS up to projected 128K designs with no personality modules or characterisers – See list
- Easy to use, menu driven operation for blankcheck, program, verify, illegal bit check, checksum, self-test
- Constant display of device type, mode and fault codings
- Individual socket LED indicators for EPROM status
- Comprehensive EPROM integrity checks – Illegal bit check, data and address shorts, constant power line monitoring
- Full safeguard protection on all sockets
- Automatic machine self-test routine
- RS232C interface supplied as standard
- Powered down sockets
- Cost effective price – £695 + VAT
- Available from stock

Write or phone for more details

2704
2708
2716(3)
2508
2758A
2758B
2516
2716
48016
2532
2732
2732A
68732-0
68732-1
68766
68764
2764
2564
MK2764
25128
27128

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